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ABSTRACT

Included are four computer programs which simulate experiments suitable for freshman engineering and physics courses. The subjects of the programs are ballistic trajectories, variable mass systems, trajectory of a particle under various forces, and design of an electronic emplifier. The report includes the problem statement, its objectives, the history of the project, its evaluation methods, and results. A bibliography is included. A listing of the programs, a typical terminal session, and the questionnaire used by the students in evaluating the programs are included in the appendixes. (Author/EB)

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Final Report

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INSTRUCTION USING EXPERIMENTS IN A COMPUTER

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Abstract

Four computer programs which simulate experiments suitable for freshman engineering and physics courses have been written. The subjects of the programs are Ballistic trajectories, Variable mass systems, Trajectory of a particle under various forces, and Design of an electronic amplifier. These programs, which have been tested by students, seem to be somewhat, but not definitely, effective. Such programs appear to be educationally valuable for certain students. Simulated experiments, while eliminating laboratory equipment difficulties, add program interaction problems which can obscure the point of an experiment equally badly.

INTRODUCTION

Statement of Problem

The basic problem being addressed was how to make engineering concepts more meaningful to the beginning student. The problem has been cogently presented by Saunders:[1]

> 'The explosive growth of modern technolgoy has and will continue to broaden the extent of the knowledge and training required for a competent engineer. This pressure has caused engineering educators to rely increasingly on theoretical models that represent broad abstract relationships or laws which preserve their validity despite technological change. This practice is often referred to as "teaching fundamentals".
>
> This trend to teaching broad abstract concepts increases the intellectual burden on the students and heightens the necessity for teachers to present these concepts thoroughly and carefully, from many different points of view. Then, the students will have a clearer comprehension of the relations of these abstract concepts to the physical world and not view them simply as abstract mathematical models divorced from reality."

An effective way to develop comprehension of abstract concepts and their relation to the physical world would be through simple but striking laborator experiments. Using these experiments, the student could explore, in her or his own way, at her or his own schedule, the implications of the abstract concept and thereby reach an intuitive understanding of the concept and its use.

Unfortunately, it is very difficult to design such simple but striking experiments. Great care must nearly always be taken in the design of elementary experiments in order that second order effects do not obscure the phenonemon to be studied. Thus the experimental equipment tends to be elaborate and somewhat hard for the student to understand. The result is that the mechanics of doing the experiment obscures the principle being illustrated. Furthermore, the experiment usually must be carefully prescribed if the student is to obtain reasonable results. Prescribed experiments do not give the student a chance to ask her or his own questions in her or his own way. Thus while an ordinary laboratory program for beginning engineering students is certainly useful in teaching experimental techniques and in

familiarizing the student with modern laboratory equipment (as well as for other reasons) it usually is not wholly effective in strengthening and extending the student's understanding of basic physical phenomenon.

The difficulties with conventional laboratories have also been described by Lagowski,[2] who has developed simulated chemistry experiments. Among the points raised are the logistics of laboratory work in a large chemistry course. Simply having space and equipment, some of which is used for only one or two experiments, can be prohibitively expensive. Further, it is often necessary in non-trivial experiments to supervise students closely in order that they not do damage to themselves or to equipment. If an integrated series of experiments on a single compound is to be made, using several different instruments, then there are tight scheduling constraints which can inhibit student independent exploration.

Another aspect of laboratory work discussed by Lagowski[2] is that the time scale of many experiments is not well matched to instructional needs. Some chemical reactions are completed in less than a second and a student can not observe the dynamics of the reaction. Other reactions, or series of tests, take hours or days which make them ill suited to student schedules.

The problem addressed, then, is that although laboratory work can greatly facilitate student learning of concepts, there are significant practical difficulties in developing effective instructional experiments.

Objective of Project

The objective of the project was to test the educational effectiveness of a set of experiments done by means of a digital computer. The computer simulates the physical phenomena being studied. The student specifies the various parameters of the experiment and the computer produces the resulting behavior.

Ultimately, four experiments were simulated: Ballistic trajectories, a variable mass system, the trajectory of a particle under various forces, and the design of an electronic amplifier. Students evaluated these programs in terms of

their educational usefulness. On the basis of their evaluation and the author's experience with the programs some conclusions can be made about the potential of simulated experiments and about computer aided instructions in general.

Simulation Programs

Simulation programs have been reviewed by Tansey and Unwin.[3] The review concerned itself with both simulations done by the students individually, as in this project, and also with group simulations, e.g., games. The strong points of simulation listed, which are pertinent here, are: 1) increased student motivation in receiving an answer rapidly, 2) flexibility in content which allows preparation for the long range future, 3) realistic and relevant problems can be studied, 4) complex problems can be handled, 5) a structured presentation can be prepared by the teacher, 6) the central aspects of the problem can be selected and stressed, 7) an opportunity is made available for the teacher to integrate the simulated situation into the course, and 8) an opportunity is presented for the student to make decisions without censure.

Simulated laboratory exercises have been developed in several fields. The chemistry laboratory experiments of Lagowski were mentioned above. In these the student selects equipment, describes how it is to be used, and is given simulated results. The usefulness and cost-effectiveness of these experiments were discussed by Lambe[4] who concludes the idea is feasible but not necessarily economical.

Electronic circuit simulations using computers have become common in electrical engineering education.[5] One of the most elaborate of these is the "Jobshop" program developed at Johns Hopkins University.[6] Students using this program can choose a design and specify component values. The program calculates the frequency response of the circuit and also the power dissipation in the resistors. An added feature is a computation of the circuit cost, both component and labor. The users of Jobshop consider it successful and point to the relatively short time it takes a student to complete a design using the computer. Thus it is practical for the student to do much more design work in courses using Jobshop than in conventional

courses. A situation is described where students with only a semester's experience were able to complete a circuit design problem, using Jobshop, a good deal quicker than experienced engineers could design the circuit using actual components.

A digital computer program which simulates the behavior of a nuclear reactor was written at the United States Military Academy.[7] An analog computer simulation of another aspect of the reactor behavior is also used at the Military Academy. The simulation has obvious economic and supervisory advantages. In fact, the training involved probably would not be feasible without computer simulations.

Other examples of the instructional use of the computer as a simulator have been reported. It should be noted that almost all of these efforts, including the three described above, were completed after the work on the present project had been started. Two earlier simulations mentioned in the proposal for this project may be worth reviewing -- (1) "Clinical Nursing Instruction",[9] and (2) "Economic Games".[10]

In the first of these, "Clinical Nursing Instruction", the care of a patient with angina pectoris and mycocardial infarction is simulated for nursing students. The nursing student is given information about the patient and his history. He or she can then prescribe a course of treatment which she or he types into the computer. The computer than reports back to the nurse the new condition of the patient. The nurse can then continue the treatment. One important advantage of this kind of teaching is that the student can obtain the experience of deciding on clinical treatment without risk to any patient.

In the "Economic Games" project, the student makes economic decisions for a city-state in Mesopotamia in 3500 B.C. Once he or she has made a decision he or she adjusts the economic conditions in the city-state, is then faced with making a new decision, at the end of a period representing six months. The game continues for a good many six month periods. The purpose of the game is to teach basic principles of economics.

Computer Aided Instruction

The relationship between the work presented here and other forms of computer aided instruction[11,12] should be apparent. Most existing CAI programs are either "drill and practice" or "tutorial". These are basically computer implementation, on different levels of sophistication, of programmed learning. The problems developed on this project are basically different as the student is not led through a sequence of small steps, each of which must be mastered thoroughly. The programs developed here do, however, offer some of the advantages of conventional CAI programs. For example, it would be simple for the instructor to have records kept of student responses, so as to learn about student behavior, strengths and weaknesses. To take another example, the messages generated by the computer are impersonal so the student does not feel, as it were, "put down" by the instructor. This impersonality may make the CAI especially valuable in the instruction of disadvantaged students.

Individualized Instruction

That different students learn in different ways has been increasingly recognized.[13] Thus, even if the programs developed on this project are not useful for all students, there may very well be students for whom they will be especially effective. Jamieson[14] compared programmed learning with "guided discovery", which is somewhat similar to simulated experiments, and found that while students seem to learn as much and as thoroughly using one technique or the other, there were variations in the speed of learning.

Simulated laboratories, which can be performed on an individual basis when the student feels himself or herself ready, fit well into a Personalized-Proctorial System of Instruction.[15] An important feature of PSI is that the student works at her or his own pace. Lectures are used primarily as vehicles of motivation. Good promise for PSI is evident.

History of Project

The original schedule for this project was one month intensive work in the summer of 1968 followed by fractional effort during the school year 1968-69. Because of prior time commitments by the Principal Investigator it was not possible to do intensive work during the summer of 1968. Therefore only fractional work was done during 1968. The Brown University Computing Laboratory installed in the fall of 1968 a new Time-sharing system which hampered operations and thus delayed the project in 1968. Full time effort was planned therefore for the month of June 1969.

Unfortunately in late April 1969, the Principal Investigator was appointed Acting Director of the Transitional Summer Program at Brown University. It was not possible to hire a faculty member or graduate student to take on this project on a full time basis but several undergraduates were hired. Six problems were programmed during the summer and students in the Transitional Summer Program experimented with several of these and contributed to their development.

The intention was that these problems would be tested by engineering freshmen during the academic year 1969-70 and further refined. A new method of charging for computing time used by undergraduates was instituted before the first semester which made it impractical to have the problems developed available to all engineering freshmen. Again, some of the problems were tested by students in the engineering freshman class in 1969 and modifications made on the basis of these trials.

At the time the proposal for this research was submitted, Fortran was available from consoles through the Brown University Computing Laboratory. At the time programming was actually begun, however, only a language developed at Brown, called BRUIN, was available at the consoles. The programs were therefore written in BRUIN and later translated in Fortran.

The project was further delayed when the Principal Investigator, Professor B. Hazeltine, went on leave for 1970 and when another major change was made in the

Computer Laboratory -- the introduction of the IBM CMS operating system. Work was finally resumed in the spring of 1972 but the programs were not finally translated into Fortran until well into the winter. (The difficulties in the translations were not Fortran problems, but arose because Fortran is only available at Brown interactively through CMS.) Six programs were written and tested in BRUIN and all were successfully translated but only four were evaluated.

When work on the project was resumed, Mr. John Fulton, a graduate student in Education and Sociology, became responsible for the evaluation. Mr. Fulton's previous experience with educational technology had been with the Education Department at Brown, where he had been responsible for their video-tape equipment and activities.

The programs as originally written were closely integrated into the freshman engineering course. One implication of the five year delay between the preparation of the proposal and the evaluation of the programs was a major reorganization of the freshman engineering course. Thus, the programs are no longer especially suitable for that course. It was, therefore, decided to hire nine undergraduates, some of whom had taken the freshman physics courses and others the freshman engineering courses, as evaluators. Actually, one of the evaluating students had so much difficulty with getting to the programs through CMS that he was not able to evaluate them usefully.

It might be pointed out that most of the programming work on this project was done by six students; of these six probably five will go onto careers in some aspect of Education. The experience of working on the project may very well have been important in their choice of career plans.

Listings of the four programs described and evaluated in the next section are included in Appendix I, plus two not evaluated. One of those not evaluated was concerned with conservation of energy using as a model the design of a roller coaster. The other was concerned with conservation of momentum using a billiard game.

Sets of computer cards giving all of the programs are available to educational institutions at no cost. They can be requested from the Division of Engineering, Brown University, Providence, RI 02912, attention of Professor B. Hazeltine. The version of the programs as evaluated have minor errors. There are presently being corrected and the versions available should be improved. (Some of the errors appearing in samples below arise in the computer terminals, not in the programs.)

Method of Evaluation

Eight student volunteers were paid a small stipend to try the four simulation programs and evaluate them. A questionnaire was provided to structure the evaluation. (See Appendix III.) In the questionnaire the volunteers were asked to rate the programs in terms of a) usefulness as introductions or reviews of the underlying principles, b) interest relative to physics or engineering laboratory exercises, (all volunteers had taken at least two physics or engineering courses), and c) the extent to which the "computerization" of the four exercises added or detracted from their usefulness (as introductions or reviews) for the volunteers.

The volunteers were asked to use a seven point scale to structure their ratings, which we converted in such a way that the most positive rating was coded "7", the most negative rating "1", and a neutral or moderate rating "4". For example, in the case of "usefulness", the volunteers were asked to:

> "Rate the usefulness of this program for you either as an introduction or review of the underlying principles. (Check one of the seven spaces that most corresponds to your own view. The labels at the ends of the scale describe spaces 1 and 7. The middle (4th) space represents the neutral opinion.)
>
> Not useful at all ___ 1 ___ 2 ___ 3 ___ 4 ___ 5 ___ 6 ___ 7 Extremely useful".

In addition to these structured ratings, the volunteers were asked to comment on the four programs in as much detail as possible, and to provide us with all printout resulting from their use of the programs.

Results of the Evaluation

Obviously more information would have been gained if more students had tested the programs or if a more detailed evaluation form had been used. However, the results obtained from the student questionnaire were fairly consistent. The rating, criticisms, and suggestions showed thoughtfulness and care. Inevitably, the need for further revisions of the programs became apparent.

In general, student reaction to the programs differed from rejection in one case,

> "All in all I am angry and disappointed with these programs", (student #1),

to acceptance and enthusiasm in a number of cases:

> "In my opinion TRAJCT is the best of the four programs. Its straightforwardness enables one to visualize the problem clearly without using vague terms which tend to confuse people. The input data are very easy to follow and the output values facilitate the understanding of the initial problem by showing the progressive steps of the moving particle". (student #6)

> "I found the program PROJCT very enjoyable to work with, and it challenged me to really think about what was going on. I felt this was the best of the four programs". (student #8)

> "Basically a very useful program AMPLIF in the design of bandpass circuitry, one could easily build a circuit with any frequency bandpass one wanted or any combination of circuits." (student #4)

Turning to the ratings of usefulness, interest, and effect of computerization, we find the mean scores for the four programs rated by seven students (student #1's ratings, all "1", were not included because it was felt that they were largely biased by a very disappointing experience with the first program he used, TRAJCT) are as follows:

a. USEFULNESS: 3.7

b. INTEREST: 3.7

c. EFFECT OF COMPUTERIZATION: 3.6

Table I

Frequency Distribution of Ratings by Rating Criteria (e.g., Interest) and Program (e.g., TRAJCT).

RATING CRITERIA	PROGRAM	RATING (1 = Least Positive) (4 = Moderately Positive (7 = Extremely Positive) 1	2	3	4	5	6	7	MEAN
USEFULNESS	TRAJCT	1	0	1	1	3	1	0	4.1
	PROJCT	0	1	1	3	1	1	0	4.0
	VARMAS	0	3	3	0	1	0	0	2.9
	AMPLIF	1	1	0	3	1	1	0	3.7
	Sub Total	2	5	5	7	6	3	0	3.7
INTEREST	TRAJCT	1	1	3	2	0	0	0	2.9
	PROJCT	1	1	0	2	2	1	0	3.9
	VARMAS	0	2	3	1	1	0	0	3.1
	AMPLIF	0	2	1	1	0	2	1	4.3
	Sub Total	2	6	7	6	3	3	1	3.6
EFFECTS OF COMPUTER-IZATION	TRAJCT	0	1	2	3	0	1	0	3.7
	PROJCT	1	0	1	3	2	0	0	3.7
	VARMAS	0	1	2	4	0	0	0	2.9
	AMPLIF	0	1	2	0	2	1	1	4.4
	Sub Total	1	3	7	10	4	2	1	3.7
	Total	5	14	19	23	13	8	2	

Recalling that a score of "1" represents the least positive rating, "4" a moderately positive rating, and "7" the most positive rating, the above ratings may be interpreted as "moderately positive" for each of the three criteria. We might add that most individual ratings were in the "moderate" category (4); (hence, the mean scores are not due to the combination of both quite positive and quite negative scores), (see Table I.)

Specific Comments on the Programs

Student criticisms and suggestions obtained from comments made on the questionnaire and on accompanying printout from runs of the programs elaborate considerably on the above ratings, and may help to understand the "reserved acceptance" of the programs.

Criticisms may be divided into three categories: a) identification of "bugs", b) criticism of printout format, and c) criticism concerned with user motivation.

a) Identification of Bugs: The volunteers found a number of program bugs. For example, the computation formula for program PROJCT breaks down at an angle of 90°. When the projectile is fired at an angle of 90° from the ground, "downrange" movement should be zero if the only external forces acting on the projectile are gravity and friction. The program attributes a slight positive downrange movement to the projectile. Such bugs will be eliminated as they are discovered.

b) Criticism of Printout Format: Most student criticisms of the programs were concerned with printout format, and in general point out the need for greater program documentation if these exercises are to "stand alone", e.g., as supplementary teaching aids. Of course, if the programs had been tightly integrated into other course activity, as originally planned, perhaps only minor revisions in format would be necessary. The student criticisms may be summarized thus:

1. Familiarity with programs is assumed; insufficient documentation is provided for programs to serve as introductions to underlying concepts.

2. Some labels in the printout need further explanations to be readily understood.
3. Learning by repeated trial and error is a slow process, especially when the computer does not indicate whether incorrect estimates of values are too high or low.
4. The program instructions do not describe how to correct typographical errors.

c) Criticism Concerned with User Motivation: Criticisms concerned with user motivation were focused mainly on difficulties encountered by the students in running the programs, which were related to program bugs, printout format, and program design:

1. Interest is reduced by program bugs.
2. The printout produced by the error routine is meaningless and boring.
3. TRAJCT and AMPLIF suffer from the need to enter so many values. Reentering all values for each problem is tedious.
4. The small 25% error margin built into some of the programs results in rejection of many value estimates early in program use, which in turn may cause early user disappointment.

Most student suggestions are focused on changes in format, to increase their understanding and thus ease of execution:

1. Readings should be explained more thoroughly, with reference made to equations where appropriate.
2. Greater explanation of the printout format should be provided in introductory statements.
3. Fundamental concepts should be reviewed in introductory statements.
4. The programs should help the student correct his errors in a manner different from trial and error.
5. Printout of error routines should be shortened or eliminated.
6. In reference to program VARMAS, smaller values for variables might facilitate understanding of underlying concepts.

Two further suggestions are related to user motivation:

1. If programs are to be used to introduce concepts, a discovery method computer-student dialogue format might be more useful than present formats.
2. Programs might be more interesting if presented in "game" format.

Summary of Results of Evaluation

Although one student became discouraged after encountering difficulty with one of the programs, student questionnaire response demonstrated general acceptance of the programs, qualified by criticism of bugs yet to be worked out of the system, and imperfect printout format. In addition, certain volunteers stated a preference for "discovery method" or "game" formats, suggesting a possible concomitant increase in student motivation with their use. Some students expressed praise and/or enthusiasm for elements of specific programs.

Conclusions

The basic purpose of the project was to determine if simulated experiments were educationally useful. Student reactions summarized in Table I, student comments, and the author's subjective impressions is that they are useful, but not overwhelmingly so. It is apparent from the results that some students find the programs agreeable and helpful. The availability, then, of simulated experiments as another option in the educational process would be beneficial.

The hope in developing the programs was that basic physical principles could be made more apparent to the learner through a computer than through laboratory equipment. With the possible exception of the electronic amplifier design (where one does not "see" the results of a real experiment anyway) the simulated experiments do not seem to focus the student's attention more effectively than conventional laboratories. Perhaps in part because the simulated experiments were badly implemented the computer seems to get in the way just as badly as the equipment used in ordinary experiments.

One unsought but certainly evident conclusion concerns the magnitude of the task required to develop effective instructional computer programs. It is apparent that just as the computer can augment the user's capabilities, it also magnifies the effect of errors. Programs must be very carefully written so minor typographical errors do not produce total disruption in the programs. Computer simulated experiments must be designed much more carefully than the equivalent actual experiment for the same educational value.

A related conclusion concerns the computer environment in which the programs are run. At Brown a variety of languages and programs are available simultaneously from a large machine through a sophisticated operating system. Such a system makes it possible economically for many users to be served by one machine. But it does add complicating procedures to using each program and such complications may be forbidding to the inexperienced user. Thus small programs supplementary to the main thrust of a course may be effectively closed off to students who most need extra assistance but are not able to sign on to the computer and manipulate instructional programs.

When the proposal was written, the hope was that models of examples used in the freshman course could be rather simply programmed and would be useful without extensive supporting material. This was an illusion. Even if the modeled principles are discussed in lectures, not all students take perfect lecture notes. Experiments are not done immediately after they are assigned. Students, quite sensibly, may want to approach the experiment differently than the instructor. Thus, ample documentation is needed, as well as flexible, forgiving programs. One conclusion of our work is that it is a major undertaking to implement significant instructional computer programs and it is not realistic to expect results from a small effort.

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APPENDIX I

Listing of Programs

a) TRAJCT

b) CON (conservation of energy, not evaluated)

c) PROJCT

d) VARMAS

e) AMPLIF

f) CON (conservation of momentum, not evaluated)

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      REAL MAGNF                                                        TRA00010
      DATA X,VX,A/3*1.0/,Y,VY,T/3*0.0/,PI/3.141593/,DT/.25/             TRA00020
     1,YES/'YE'/                                                        TRA00030
      WRITE (6,1000)                                                    TRA00040
 1000 FORMAT (' THIS PROGRAM DEMONSTRATES THE RELATION OF FORCE TO VELOCTRA00050
     1ITY.'/' IMAGINE A PARTICLE IN A COORDINATE SYSTEM. YOU WILL ENTER TRA00060
     1ALL'/' THE INITIAL DATA ON THE PARTICLE AND THE PROGRAM WILL GIVE TRA00070
     1YOU',                                                             TRA00080
     1   /' READINGS ON THE POSITION OF THE PARTICLE WITH TIME.'//' YOU TRA00090
     1MUST ALWAYS INCLUDE THE DECIMAL POINT.'//                '     ENTETRA00100
     1R THE INITIAL X AND Y COORDINATES.  INCLUDE DECIMAL POINTS.')     TRA00110
    1 WRITE (6,1020)                                                    TRA00120
 1020 FORMAT (' X = ')                                                  TRA00130
      READ (5,100) X                                                    TRA00140
  100 FORMAT (F10.0)                                                    TRA00150
      WRITE (6,1001)                                                    TRA00160
 1001 FORMAT (' Y =')                                                   TRA00170
      READ (5,100) Y                                                    TRA00180
      WRITE (6,1002)                                                    TRA00190
 1002 FORMAT (' VELOCITY IN X DIRECTION=')                              TRA00200
      READ (5,100) VX                                                   TRA00210
 1003 FORMAT (' VELOCITY IN Y DIRECTION=')                              TRA00220
      WRITE (6,1003)                                                    TRA00230
      READ (5,100) VY                                                   TRA00240
   10 DT=0.25                                                           TRA00250
      WRITE (6,1004)                                                    TRA00260
 1004 FORMAT (' ENTER THE ANGLE (IN DEGREES) AT WHICH THE FORCE',/,     TRA00270
     1' VECTOR ACTS ',/,' PHI=')                                        TRA00280
      READ (5,100) PHI                                                  TRA00290
      WRITE (6,1005)                                                    TRA00300
 1005 FORMAT (' ENTER THE MAGNITUDE OF THE FORCE.'/' MAGNF = ')         TRA00310
      READ (5,100) MAGNF                                                TRA00320
      WRITE (6,1006)                                                    TRA00330
 1006 FORMAT (' DO YOU WANT THE ANGLE OF THE FORCE TO BE CONSTANT?',/,   TRA00340
     1' (INDEPENDENT OF THE VELOCITY)     YES   OR   NO',/)             TRA00350
      Q=0.                                                              TRA00360
      READ (5,110) RQ                                                   TRA00370
      IF (RQ.EQ.YES) Q=1.                                               TRA00380
      PHI=PI/180*PHI                                                    TRA00390
      T=0.0                                                             TRA00400
      WRITE (6,1007)                                                    TRA00410
 1007 FORMAT (' HOW MANY READINGS DO YOU WANT?')                        TRA00420
   20 READ (5,100) RN                                                   TRA00430
      N=RN                                                              TRA00440
      WRITE (6,1008)                                                    TRA00450
      DO 30 I=1,N                                                       TRA00460
      T=T+DT                                                            TRA00470
      IF (VX.EQ.0.0) THETA=PI/2                                         TRA00480
      IF (VX.LT.0.0) THETA=ATAN(VY/VX)+PI                               TRA00490
      IF (VX.GT.0.0) THETA=ATAN(VY/VX)                                  TRA00500
      CHI=THETA+PHI                                                     TRA00510
      IF (Q.EQ.1.0) CHI=PHI                                             TRA00520
      AX=COS(CHI)                                                       TRA00530
      AY=SIN(CHI)                                                       TRA00540
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FILE: PRINT    SYSIN    P1                    BROWN UNIVERSITY COMPUTING LABORATOR

      VX=VX+DT*AX                                                          TRA00550
      VY=VY+DT*AY                                                          TRA00560
      X=X+DT*VX                                                            TRA00570
      Y=Y+DT*VY                                                            TRA00580
      ALPHA=3*PI/2                                                         TRA00590
      IF (Y.EQ.0.0.AND.Y.GT.0.0) ALPHA=PI/2                                TRA00600
      IF (X.LT.0.0) ALPHA=ATAN(Y/X)+PI                                     TRA00610
      IF (Y.GT.0.0) ALPHA=ATAN(Y/X)                                        TRA00620
      V=SQRT (VX**2+VY**2)                                                 TRA00630
      R=SQRT (X*X+Y*Y)                                                     TRA00640
      ALPHA=ALPHA*180/PI                                                   TRA00650
      WRITE (6,1018) ALPHA,X,Y,T,R,VX,VY,V                                 TRA00660
 1018 FORMAT (4F10.3/,4F10.3/ )                                            TRA00670
 1008 FORMAT ('      ALPHA        X          Y          T',/,              TRA00680
     1'          R         VX         VY         V')                      TRA00690
  110 FORMAT (A2)                                                         TRA00700
   30 CONTINUE                                                            TRA00710
      WRITE (6,1009)                                                       TRA00720
 1009 FORMAT (' IF YOU WISH AFTER MORE READINGS, ENTER THE NUMBER YOU WATRA00730
     1NT.')                                                               TRA00740
      READ (5,100) RN                                                      TRA00750
      N=RN                                                                 TRA00760
      IF (N.NE.0) GO TO 20                                                 TRA00770
      WRITE(6,1010)                                                        TRA00780
 1010 FORMAT (' DO YOU WANT TO RUN THROUGH THE PROGRAM AGAIN?',/,          TRA00790
     1' YES OR NO',/)                                                     TRA00800
      READ (5,110,END=999) ANS                                             TRA00810
      IF (ANS.EQ.YES) GO TO 1                                              TRA00820
  999 STOP                                                                 TRA00830
      END                                                                  TRA00840

CP67USERID  TEMPC144    05/23/73     13.11.51     032-002-006    ******************
      DIMENSION X(100),XMM(100),YMM(100),F(100)                            CON0C010
      DATA YES /'YE'/                                                      CON00020
      REAL*4 KE                                                            CON00030
      WRITE (6,10)                                                         CON00040
   10 FORMAT (/' THE PURPOSE OF THIS PROGRAM IS TO HELP YOU DESIGN A ROLCON00050
     1LER '    /' COASTER.  YOU WILL ENTER THE COORDINATES OF EACH MAXIMUCON00060
     2M AND'   /' MINIMUM OF THE COASTER AND THE COEFFICIENT OF FRICTION CON00070
     3FOR THE LEG', /' FOLLOWING EACH SET OF POINTS.  I WILL OUTPUT THE CON00080
     4DATA OF THE ROLLER',/' COASTER RUN.')                               CON00090
      GO TO 15                                                             CON00100
   14 WRITE (6,74)                                                         CON00110
   15 WRITE (6,20)                                                         CON00120
   20 FORMAT (/' ENTER WEIGHT OF COASTER CAR.  INCLUDE DECIMAL POINT.')    CON00130
      READ (5,30) XMASS                                                    CON00140
   30 FORMAT (F10.0)                                                       CON00150
      IF (XMASS - 1.E06) 35,35,14                                          CON00160
   33 WRITE (6,74)                                                         CON00170
   35 WRITE (6,40)                                                         CON00180
   40 FORMAT (/' HOW MANY MAXIMUM AND MINIMUM POINTS DOES YOUR COASTER HCON00190
     1AVE?',   /' THERE MUST BE AT LEAST 2.  INCLUDE DECIMAL POINT.')     CON00200
      READ (5,30) XMMM                                                     CON00210
      NMM=XMMM                                                             CON00220
      IF (XMMM .GT.1.E02) GO TO 33                                         CON00230
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      WRITE (6,50)                                                          CON00240
   50 FORMAT (/' NOW ENTER THE X AND Y COORDINATES AND THE FRICTION FOR     CON00250
     1EACH',  /' MAX AND MIN, IN ORDER, IN THE FOLLOWING DECIMAL FORM:'     CON00260
     2        /' XXXX.X YYYY.Y FFFF.F')                                     CON00270
      DO 70 I=1,NMM                                                         CON00280
      READ (5,60) XMM(I),YMM(I),F(I)                                        CON00290
   60 FORMAT (3(F6.0,1X))                                                   CON00300
   70 CONTINUE                                                              CON00310
      GO TO 75                                                              CON00320
   73 WRITE (6,74)                                                          CON00330
   74 FORMAT (/' VALUE EXCEEDS LIMIT.')                                     CON00340
   75 WRITE (6,80)                                                          CON00350
   80 FORMAT (/' AT HOW MANY POINTS ALONG THE RUN DO YOU WANT DATA?',       CON00360
     1        /' INCLUDE DECIMAL POINT.')                                   CON00370
      READ (5,30) XNY                                                       CON00380
      NY=XNY                                                                CON00390
      IF ( XNY .GT. 1.E02 ) GO TO 73                                        CON00400
      WRITE (6,90)                                                          CON00410
   90 FORMAT (/' ENTER EACH X COORDINATE AT WHICH YOU WANT DATA,'           CON00420
     1        /' ONE DECIMAL VALUE PER LINE.')                              CON00430
      DO 95 I=1,NY                                                          CON00440
      READ (5,30) X(I)                                                      CON00450
      IF (X(I) .GT. XMM(NMM) )GO TO 92                                      CON00460
      GO TO 95                                                              CON00470
   92 WRITE (6,93)                                                          CON00480
   93 FORMAT (/' X BEYOND LAST MAX OR MIN POINT.  TRY AGAIN.')              CON00490
      READ (5,30) X(I)                                                      CON00500
   95 CONTINUE                                                              CON00510
      G=32.2                                                                CON00520
      IF ( YMM(1) .EQ. 0.0 ) GO TO 110                                      CON00530
      WRITE (6,100)                                                         CON00540
  100 FORMAT (/' THE FIRST MAXIMUM POINT MUST BE AT Y = 0.0')               CON00550
      GO TO 35                                                              CON00560
  110 XINEN = XMASS * G * YMM(1)                                            CON00570
      WRITE (6,115)                                                         CON00580
  115 FORMAT (/'      X COORD    Y COORD       VELOCITY          K E       CON00590
     1    P E')                                                            CON00600
      DO 140 I=1,NY                                                         CON00610
      DO 120 J=2,NMM                                                        CON00620
      IF ( X(I) .LE. XMM(J) ) GO TO 130                                     CON00630
  120 CONTINUE                                                              CON00640
  130 DY= YMM(J) - YMM(J-1)                                                 CON00650
      DY= YMM(J) - YMM(J-1)                                                 CON00660
      Y= YMM(J-1) + (DY/DX) * (X(I) - XMM(J-1))                             CON00670
      PE = XMASS *G * Y                                                     CON00680
      H= SQRT ( (DX*DX) + (DY*DY) )                                         CON00690
      DH = H * ( X(I) - XMM(J-1))/DX                                        CON00700
      PE = XMASS * G * F(J-1) * DH * DX/H                                   CON00710
      KE = XINEN - PE - PE                                                  CON00720
      IF (KE .LE. 0.0 ) GO TO 150                                           CON00730
      V  = ((2.0 * KE)/XMASS) **0.500                                       CON00740
      IF (V .LE. 0.01) GO TO 150                                            CON00750
      WRITE (6,145) X(I),Y,V,KE,PE                                          CON00760
  140 CONTINUE                                                              CON00770
  145 FORMAT (1X,2F10.2,F15.5,2F15.4)                                       CON00780
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      GO TO 170                                                          CON00790
  150 WRITE (6,160)                                                      CON00800
  160 FORMAT (/' SORRY, BUT YOUR ROLLER COASTER HAS STOPPED.'),          CON00810
  170 WRITE (6,180)                                                      CON00820
  180 FORMAT (/' DO YOU HAVE MORE DATA? ... YES OR NO')                  CON00830
      READ (5,190) YN                                                    CON00840
  190 FORMAT (A2)                                                        CON00850
      IF ( YN .EQ. YES ) GO TO 15                                        CON00860
      STOP                                                               CON00870
      END                                                                CON00880

CP67USERID TEMP0144   05/23/73   10.11.14   032-002-006  ****************
      DIMENSION VEL(3),ANG(3),DSPEED(3),DANGLE(3)                        PRO00010
      REAL K                                                             PRO00020
      DATA A,B,C,D,E,F,H,K/8*0.0/,I,J/2*0/,PI/3.141593/                  PRO00030
     1,YES/'YE'/,FOOT/'FO'/                                              PRO00040
 1010 VEL(1)=15                                                          PRO00050
      VEL(2)=45                                                          PRO00060
      VEL(3)=90                                                          PRO00070
      ANG(1)=PI/12                                                       PRO00080
      ANG(2)=PI/4                                                        PRO00090
      ANG(3)=PI/2                                                        PRO00100
      GO TO 8000                                                         PRO00110
 1100 I=I+1                                                              PRO00120
      IF (I.LT.4) GO TO 1115                                             PRO00130
      GO TO 7400                                                         PRO00140
 1115 J=0                                                                PRO00150
 1200 J=J+1                                                              PRO00160
      IF (J.LT.4) GO TO 2050                                             PRO00170
      IF (J.EQ.4) GO TO 1100                                             PRO00180
      GO TO 1300                                                         PRO00190
 7400 IF (Z.EQ.0.0) WRITE (6,1060)                                       PRO00200
      IF (Z.NE.0.) GO TO 7511                                            PRO00210
 1060 FORMAT (' DO YOU WISH TO CONTINUE (YES OR NO)')                    PRO00220
      READ (5,110) REPLY                                                 PRO00230
  110 FORMAT (A2)                                                        PRO00240
  100 FORMAT (F10.0)                                                     PRO00250
      IF (REPLY.NE.YES) STOP                                             PRO00260
      IF (Z.EQ.0) WRITE (6,1061)                                         PRO00270
 1061 FORMAT (' WANT TO ENTER VALUES ON YOUR OWN"')                      PRO00280
      READ (5,110) REPLY                                                 PRO00290
      IF (REPLY.EQ.YES) GO TO 7520                                       PRO00300
 7511 IF (D.EQ.1.0) GO TO 4000                                           PRO00310
      IF (D.NE.1.0) GO TO 3000                                           PRO00320
 7520 WRITE (6,1012)                                                     PRO00330
 1012 FORMAT (' ENTER INITIAL VELOCITY')                                 PRO00340
      READ (5,100) V1                                                    PRO00350
      WRITE (6,1013)                                                     PRO00360
 1013 FORMAT (' ENTER INITIAL ANGLE')                                    PRO00370
      READ (5,100) ANGLE                                                 PRO00380
      V2=ANGLE*PI/180.                                                   PRO00390
      C=0.                                                               PRO00400
      F=10.                                                              PRO00410
 2050 IF (D.EQ.1.0) GO TO 3115                                           PRO00420
      IF (K.EQ.1.0) GO TO 5115                                           PRO00430
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      IF (H.EQ.1.0) GO TO 6115                                          PRO00440
      V1=VEL(I)                                                         PRO00450
      V2=ANG(J)                                                         PRO00460
2127  IF (D.EQ.0.0) ED=0.                                               PRO00470
      IF (D.NE.0.0) GO TO 3130                                          PRO00480
      IF (E.EQ.0.0) ED=0.                                               PRO00490
      IF (K.EQ.1.0) GO TO 5130                                          PRO00500
      IF (H.EQ.1.0) GO TO 6130                                          PRO00510
2130  V2D=V2*180./PI                                                    PRO00520
      WRITE (6,1020) V1,V2D                                             PRO00530
1020  FORMAT (' INITIAL VELOCITY IS ',F15.7,'FT/SEC',                   PRO00540
     1        ' ANGLE OF DEPARTURE IS ', F6.2,'DEGREES')                PRO00550
        IC=C                                                            PRO00560
      GO TO (2160,2160,2201,2160,2160,2160,2160,2192,2224),IC           PRO00570
2160  WRITE (6,1021)                                                    PRO00580
1021  FORMAT (' GIVE YOUR ESTIMATE OF THE HIPOINT')                     PRO00590
      READ (5,100) ESTH                                                 PRO00600
      G=32.                                                             PRO00610
      VV=V1-ED                                                          PRO00620
      T1=VV*SIN(V2)/G                                                   PRO00630
      HIPOIN=VV*SIN(V2)*T1-0.5*G*T1**2                                  PRO00640
 2186 C=8                                                               PRO00650
      IF (ABS(ESTH-HIPOIN).LE.0.25*HIPOIN) GO TO 2130                   PRO00660
 1300 IF (A.EQ.1.0) WRITE (6,1030)                                      PRO00670
1030  FORMAT (' *** LAST CHANCE ***')                                   PRO00680
      IF (ESTH-HIPOIN.LT.0.0) GO TO 1315                                PRO00690
      WRITE (6,1031)                                                    PRO00700
1031  FORMAT (' YOUR HIPOINT ESTIMATE IS TOO HIGH.')                    PRO00710
      IF (A.GE.2.0) GO TO 1324                                          PRO00720
      WRITE (6,1032)                                                    PRO00730
1032  FORMAT (' ENTER A NEW ESTIMATE')                                  PRO00740
1323  READ (5,100) ESTH                                                 PRO00750
1324  A=A+1.                                                            PRO00760
      IF (A.LT.3.0) GO TO 2186                                          PRO00770
      IF (A.LT.3.0) GO TO 2186                                          PRO00770
      WRITE (6,1033)                                                    PRO00780
1033  FORMAT (' DID YOU REALLY TRY? ALL OF YOUR ESTIMATES WERE MORE ',/,PRO00790
     1' THAN 25% OFF!!')                                                PRO00800
      GO TO 2130                                                        PRO00810
1315  WRITE (6,1040)                                                    PRO00820
1315  WRITE (6,1040)                                                    PRO00820
1040  FORMAT (' YOUR HIPOINT ESTIMATE IS TOO LOW.')                     PRO00830
      IF (A.LT.2.0) GO TO 1323                                          PRO00840
      GO TO 1324                                                        PRO00850
 2192 WRITE (6,1034) HIPOIN                                             PRO00860
 1034 FORMAT (' ***GOOD ESTIMATE ***',/,' THE  HIPOINT IS',1X,F10.3)    PRO00870
      A=0                                                               PRO00880
      C=3                                                               PRO00890
      GO TO 2130                                                        PRO00900
2201  WRITE (6,1050)                                                    PRO00910
1050  FORMAT (' GIVE YOUR ESTIMATE OF THE RANGE.')                      PRO00920
      READ (5,100) ESTR                                                 PRO00930
      RANGE=V1*COS(V2)*2*T1                                             PRO00940
2216  C=9.                                                              PRO00950
      IF (ABS(ESTR-RANGE).GT.0.25*RANGE) GO TO 1400                     PRO00960
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      GO TO 2130                                                        PRO00970
2224  IF (B.LT.3.0) WRITE (6,1051) RANGE                                PRO00980
1051  FORMAT (' ***** GOOD ESTIMATE *****',/,' THE RANGE IS ',F10.3)    PRO00990
      C=0.0                                                             PRO01000
      B=0.0                                                             PRO01010
      IF (B.EQ.10.) GO TO 7400                                          PRO01020
      GO TO 1200                                                        PRO01030
1400  IF (B.EQ.1.0) WRITE (6,1030)                                      PRO01040
      IF (ESTR-RANGE.LT.0.0) GO TO 1415                                 PRO01050
      WRITE (6,1053)                                                    PRO01060
1053  FORMAT (' YOUR RANGE ESTIMATE IS TOO LONG.')                      PRO01070
1423  IF (B.GE.2.) GO TO 1424                                           PRO01080
      WRITE (5,1032)                                                    PRO01090
      READ (5,100) ESTR                                                 PRO01100
1424  B=B+1.                                                            PRO01110
      IF (B.LT.3.0) GO TO 2216                                          PRO01120
      WRITE (6,1033)                                                    PRO01130
      GO TO 2130                                                        PRO01140
1415  WRITE (6,1054)                                                    PRO01150
1054  FORMAT (' YOUR RANGE ESTIMATE IS TOO SHORT')                      PRO01160
      GO TO 1423                                                        PRO01170
4000  IF (B.EQ.1.0) STOP                                                PRO01180
      A=0.                                                              PRO01190
      B=0.                                                              PRO01200
      C=0.                                                              PRO01210
      D=1.                                                              PRO01220
      E=0.                                                              PRO01230
      F=1.                                                              PRO01240
      H=0.                                                              PRO01250
      K=0.                                                              PRO01260
      GO TO 8000                                                        PRO01270
4105  WRITE (6,1070)                                                    PRO01280
      READ (5,100) WHICH                                                PRO01290
1070  FORMAT (' IS THE PROJECTILE A FOOTBALL (1.0) OR A SOCCERBALL (0.0)PRO01300
     1')                                                                PRO01310
      IF (WHICH.EQ.1.) GO TO 5000                                       PRO01320
      GO TO 6000                                                        PRO01330
5000  DSPEED(1)=20.                                                     PRO01340
      DSPEED(2)=40.                                                     PRO01350
      DSPEED(3)=80.                                                     PRO01360
      SP=0.196                                                          PRO01370
      DANGLE(1)=20*PI/180.                                              PRO01380
      DANGLE(2)=40*PI/180.                                              PRO01390
      DANGLE(3)=80*PI/180.                                              PRO01400
      A=0.                                                              PRO01410
      B=0.                                                              PRO01420
      C=0.                                                              PRO01430
      D=1.                                                              PRO01440
      E=0.                                                              PRO01450
      F=0.                                                              PRO01460
      H=0.                                                              PRO01470
      K=0.                                                              PRO01480
      DC=2.                                                             PRO01490
      AD=2.458 E-3                                                      PRO01500
      GO TO 8000                                                        PRO01510
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3115  V1=DSPEED(I)                                                    001520
      V2=DANGLE(J)                                                    001530
3130  RD=DC*AD*SF*V1**2                                               001540
      GO TO 2130                                                      001550
8000  WRITE (6,8001)                                                  001560
8001  FORMAT (' THE MINIMUM DI[illegible]SIONS FOR A FIELDHOUSE USED FOR FOOTBA PRO01570
     1L',/,' SOCCER, BASEBALL [illegible]ST BE DETERMINED. TO DO THIS, YOU',/, PRO01580
     2' MUST ESTIMATE THE MAXI[illegible]M HEIGHT, AND RANGE OF A PROJECTILE',/ PRO01590
     3' WITH VARYING INITIAL VELOCITIES & ANGLES OF DEPARTURE.',/,      PRO01600
     4' AT FIRST YOU WILL BE GIVEN THE VALUES FOR THE INITIAL VELOCITY',PRO01610
     5/,' AND ANGLE OF DEPARTURE. THE GIVEN VALUES WILL BE VARIED THREE'PRO01620
     6,/,' TIMES EACH. YOU WILL BE LATER ALLOWED TO ENTER YOUR OWN VALUEPRO01630
     1S'/,                                                            PRO01640
     7' IF YOUR ESTIMATES COME WITHIN 25% OF THE CORRECT ANSWERS, THE', PRO01650
     8/' ANSWERS WILL BE PRINTED OUT AND A NEW SET OF VALUES WILL BE ',/PRO01660
     9,' INSERTED. YOU WILL HAVE THREE TRIES PER SET OF VALUES.'/)    PRO01670
8113  IF (D.EQ.0.0) GO TO 8120                                        PRO01680
      IF (F.EQ.1.0) GO TO 8220                                        PRO01690
      GO TO 8160                                                      PRO01700
8120  WRITE (6,1080)                                                  PRO01710
1080  FORMAT (' IN PART ONE THE PROJECTILE IS A SOCCERBALL, DRAG IS',/,'PRO01720
     1 NEGLECTED.')                                                   PRO01730
      GO TO 1100                                                      PRO01740
8160  WRITE (6,1081)                                                  PRO01750
1081  FORMAT (' IN PART TWO THE PROJECTILE IS A BASEBALL, THE FORCE OF',PRO01760
     1/,' DRAG IS AFFECTING THE MINIMUM RANGE, AND THE HEIGHT OF THE',/,PRO01770
     2'PROJECTILE. ESTIMATE ACCORDINGLY. THE DRAG COEFFICIENT FOR A',/, PRO01780
     3'BASEBALL IS 2.')                                               PRO01790
      GO TO 1100                                                      PRO01800
8220  WRITE (6,1082)                                                  PRO01810
1082  FORMAT (' IN PART 3 THE PROJECTILE WILL EITHER BE A FOOTBALL ',/, PRO01820
     1'OR A SOCCERBALL, YOU WILL CHOOSE. THE EFFECT OF DRAG IS NOT',/, PRO01830
     2'NEGLECTED. NOTE: DRAG COEFFICIENT OF A SPHEROID OF R=1.5 IS 2',/,PRO01840
     3'FOR R=7 COEFF=3. ALSO THE SHAPE OF THE FOOTBALL EFFECTS THE',/, PRO01850
     4'DRAG COEFFICIENT.')                                            PRO01860
      GO TO 4105                                                      PRO01870
5000  DC=1.0                                                          PRO01880
      AD=1.0                                                          PRO01890
      SF=.1                                                           PRO01900
      K=1.                                                            PRO01910
      GO TO 1100                                                      PRO01920
5115  V1=DSPEED(I)                                                    PRO01930
      V2=DANGLE(J)                                                    PRO01940
5130  RD=DC*AD*SF*V1**2                                               PRO01950
      GO TO 2130                                                      PRO01960
6000  DC=1.                                                           PRO01970
      AD=1.                                                           PRO01980
      H=1.                                                            PRO01990
      GO TO 1100                                                      PRO02000
6115  V1=VEL(I)                                                       PRO02010
      V2=DANGLE(J)                                                    PRO02020
6130  RD=DC*AD*SF*V1**2                                               PRO02030
      GO TO 2130                                                      PRO02040
      END                                                             PRO02050
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CP67USERID  TEMP0144    05/23/73    13.11.27    032-002-006    ********************
      REAL*8 COMENT(3),KOMENT(3,5)                                          VAR00010
      REAL MULT(3)                                                          VAR00020
      DIMENSION AREAY(4,4)                                                  VAR00030
      DATA VAL1,VAL2,VAL3,VAL4/30000.,10000.,5000.,10./,MULT/1.,-.5,.5/     VAR00040
      DATA COMENT/'VELOCITY','THRUST  ','BOTH    '/,                        VAR00050
     1KOMENT/3*' ','WEIGHT O','F FULL R','OCKET  ','WEIGHT O','F EMPTY'     VAR00060
     2,'ROCKET  ','EXHAUST ','VELOCITY',' ','RATE OF ','FUEL EXH','AUSTE   VAR00070
     3D'/,YES/'YES '/                                                       VAR00080
      WRITE (6,1000)                                                        VAR00090
 1000 FORMAT (' A ROCKET WEIGHS 30000 LBS WHEN FUELED UP ON THE LAUNCH-'    VAR00100
     1,/' ING PAD. IT IS FIRED VERTICALLY UPWARD AND, AT BURNOUT,',/,       VAR00110
     2' WEIGHS 10000 LBS GASES ARE EXHAUSTED WITH A VELOCITY',/,            VAR00120
     3' OF 5000 FT /SEC, RELATIVE TO THE ROCKET (EXHAUST VELOCITY), ',/,    VAR00130
     4' AND AT THE RATE OF 10 SLUGS/SEC, BOTH BEING ASSUMED TO BE',/,       VAR00140
     5' CONSTANT WHILE THE FUEL IS BURNING.',//,                            VAR00150
     6' THE FOUR VALUES IN THIS PROBLEM WILL BE VARIED ONE AT A TIME',/,/,  VAR00160
     7' FOR EACH VARIABLE, YOU WILL BE GIVEN NEW VALUES, MAXIMUM OF 3.'/    VAR00170
     8,' AFTER USING THE STOCK VALUES FOR ALL FOUR VARIABLES YOU WILL',/    VAR00180
     9' BE GIVEN AN OPPORTUNITY TO ENTER YOUR OWN VALUES.')                 VAR00190
      V1=VAL1                                                               VAR00200
      V2=VAL2                                                               VAR00210
      V3=VAL3                                                               VAR00220
      V4=VAL4                                                               VAR00230
      I=1                                                                   VAR00240
      K=1                                                                   VAR00250
      DO M=1,4                                                              VAR00260
        DO 10 L=1,4                                                         VAR00270
        AREAY(M,L)=0                                                        VAR00280
 10     IF (M.EQ.L) AREAY(M,L)=1                                            VAR00290
        IF (J.EQ.1) GO TO 1042                                              VAR00300
 1040 WRITE (6,1001) (KOMENT(JJ,J),JJ=1,3)                                  VAR00310
 1001 FORMAT (' NEW VALUES,THE VARIABLE BEING VARIED IS THE ',3A8)          VAR00320
 1042 WRITE (6,1002) V1,V2,V3,V4                                            VAR00330
 1002 FORMAT (' WEIGHT OF',/' FULL ROCKET',F13.3,/,' EMPTY ROCKET',F13.3    VAR00340
     1,/,' FT/SEC.',F13.3,/,' SLUGS/SEC.',F13.3)                            VAR00350
      FTHRUS=V3+V4                                                          VAR00360
      ENDVEL=-V3*ALOG(1+(V2-V1)/V1)*3600./5280.                             VAR00370
      I=1                                                                   VAR00380
 1060 WRITE (6,1003)                                                        VAR00390
 1003 FORMAT (' ENTER ESTIMATES OF THRUST, & FINAL VELOCITY (IN LBS&',/,    VAR00400
     1'  MILES/HOUR)')                                                      VAR00410
      WRITE (6,1020)                                                        VAR00420
 1020 FORMAT (' THRUST=')                                                   VAR00430
      READ (5,100) THRUST                                                   VAR00440
      WRITE (6,1021)                                                        VAR00450
 1021 FORMAT (' VELOCITY=')                                                 VAR00460
      READ (5,100) VELOC                                                    VAR00470
      COND1=0.                                                              VAR00480
      IF (ABS(THRUST-FTHRUS).GT.0.25*FTHRUS) COND1=2.                       VAR00490
      IF (ABS(VELOC-ENDVEL).GT.0.25*ENDVEL) COND1=COND1+1.                  VAR00500
      IF (COND1.EQ.0.) GO TO 1200                                           VAR00510
      WRITE (6,1013) COMENT(COND1)                                          VAR00520
 1013 FORMAT (' YOUR ESTIMATE OF ',A8,' WAS MORE THAN 25% OFF')             VAR00530
      IF (I.EQ.3) GO TO 1700                                                VAR00540
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      I=I+1                                                              VAR00550
      GO TO 1060                                                         VAR00560
1200  WRITE (6,1004) ETHRUS,ENDVEL                                       VAR00570
1004  FORMAT (' THE CORRECT THRUST IS',F10.3,/,' THE CORRECT FINAL VELOC VAR00580
     1ITY IS',F10.3)                                                     VAR00590
      IF (J.EQ.1.OR.K.GE.4) GO TO 1250                                   VAR00600
      IF (J.GE.6) GO TO 1320                                             VAR00610
      WRITE (6,1005)                                                     VAR00620
1005  FORMAT (' DO YOU WANT NEW INITIAL VALUES AT THIS POINT? YES OR NO  VAR00630
     1')                                                                 VAR00640
      READ (5,100) ANS                                                   VAR00650
      IF (ANS.EQ.YES) GO TO 1270                                         VAR00660
1250  J=J+1                                                              VAR00670
      K=1                                                                VAR00680
      IF (J.GE.6) GO TO 1320                                             VAR00690
1270  V2=VAL2+(VAL2*ARRAY((J-1),2)*MULT(K))                              VAR00700
      V1=VAL1+((VAL1-VAL2)*ARRAY(J-1,1)*MULT(K))                         VAR00710
      V3=VAL3+(VAL3*ARRAY(J-1,3)*MULT(K))                                VAR00720
      V4=VAL4+(VAL4*ARRAY(J-1,4)*MULT(K))                                VAR00730
      K=K+1                                                              VAR00740
      GO TO 1040                                                         VAR00750
1320  WRITE (6,1006)                                                     VAR00760
1006  FORMAT (' DO YOU WANT TO ENTER YOUR OWN VALUES"')                  VAR00770
      READ (5,125) ANS                                                   VAR00780
  125 FORMAT (A3)                                                        VAR00790
  100 FORMAT (F20.0)                                                     VAR00800
      IF (ANS.EQ.YES) STOP                                               VAR00810
      WRITE (6,1007)                                                     VAR00820
1007  FORMAT (' ENTER WEIGHT OF ROCKET WITH FUEL.')                      VAR00830
      READ (5,100) V1                                                    VAR00840
1360  WRITE (6,1008)                                                     VAR00850
1008  FORMAT (' ENTER WEIGHT OF ROCKET EMPTY')                           VAR00860
      READ (5,100) V2                                                    VAR00870
      IF ((V1-V2).GT.0.00001 ) GO TO 1400                                VAR00880
      IF ((V1-V2).LT.-0.00001) GO TO 1395                                VAR00890
      ETHRUS=0.0                                                         VAR00900
      ENDVEL=0.0                                                         VAR00910
      GO TO 1060                                                         VAR00920
1395  WRITE (6,1009)                                                     VAR00930
1009  FORMAT (' THE ROCKET SHOULD WEIGH MORE THAN IT DOES EMPTY, REENTER  VAR00940
     1')                                                                 VAR00950
      GO TO 1360                                                         VAR00960
1400  WRITE (6,1010)                                                     VAR00970
1010  FORMAT (' ENTER THE RATE AT WHICH FUEL IS EJECTED')                VAR00980
      READ (5,100) V3                                                    VAR00990
      WRITE (6,1011)                                                     VAR01000
1011  FORMAT (' ENTER THE RATE AT WHICH FUEL IS BURNED')                 VAR01010
      READ (5,100) V4                                                    VAR01020
      GO TO 1042                                                         VAR01030
1700  WRITE (6,1012)                                                     VAR01040
1012  FORMAT (' YOUR GUESSES ARE ALL USED UP, YOUR ESTIMATES ARE ALL ',/ VAR01050
     1,' SHAKY')                                                         VAR01060
      GO TO 1200                                                         VAR01070
      END                                                                VAR01080
```

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CP67USERID TEMP0148    05/23/73    13.10.47    032-002-006    ******************
      DIMENSION  R(100),L(100),C(100),FM(100)                          AMP00010
      DATA YES/'YE'/                                                   AMP00020
      REAL NO,L                                                        AMP00030
      WRITE (6,1000)                                                   AMP00040
 1000 FORMAT (' ARE YOU FAMILIAR WITH THIS PROGRAM?')                  AMP00050
      READ (5,125,END=1) ANS                                           AMP00060
  125 FORMAT (A2)                                                      AMP00070
  100 FORMAT (F20.0)                                                   AMP00080
    1 IF (ANS.EQ.YES) GO TO 10                                         AMP00090
      WRITE (6,1001)                                                   AMP00100
 1001 FORMAT (/,' THIS PROGRAM WILL HELP YOU DESIGN A MULTISTAGE',/,   AMP00110
     1' BANDPASS AMPLIFIER. THE BASIC CIRCUIT CONSISTS OF A RESISTOR',/,AMP00120
     2' AND INDUCTOR IN SERIES WITH A CAPACITOR MOUNTED PARALLEL TO',/, AMP00130
     3' THE RESISTOR & INDUCTOR. YOU MAY SPECIFY UP TO 100 STAGES,',/, AMP00140
     4' AND YOU WILL ENTER THE VALUES FOR THE R, C, AND L FOR EACH',/,  AMP00150
     5' STAGE. AFTER YOU HAVE ENTERED THE VALUES,THE PROGRAM WILL',/,   AMP00160
     6' GIVE YOU THE FREQUENCIES AT WHICH EACH STAGE GIVES MAXIMUM',/,  AMP00170
     7' GAIN. YOU CAN THEN GET A READOUT OF THE GAIN FOR YOUR AMPLIFIER'AMP00180
     8/,' OVER A RANGE OF FREQUENCIES. TO DO THIS YOU WILL ENTER',/,    AMP00190
     9' THE INITIAL FREQUENCY, THE INCREMENT & THE FINAL FREQUENCY OF',/AMP00200
     A' THE RANGE OVER WHICH YOU WANT TO KNOW THE GAIN. THE DATA WILL',/AMP00210
     B' THEN BE PRINTED OUT, AND YOU WILL BE ASKED IF YOU WANT TO RUN',/AMP00220
     C' THE PROGRAM AGAIN.',//)                                        AMP00230
   10 WRITE (6,1002)                                                   AMP00240
 1002 FORMAT (/,' HOW MANY STAGES DOES YOUR AMPLIFIER HAVE?',/,' INCLUDEAMP00250
     1 A DECIMAL POINT WITH ALL ENTRIES OR RESULTS WILL BE OFF BY SEVERAAMP00260
     2L',/,' ORDERS OF MAGNITUDE.')                                    AMP00270
      ISTEMP=0                                                         AMP00280
      READ (5,100) S                                                   AMP00290
      IS=S                                                             AMP00300
      IF(IS.EQ.1) GO TO 15                                             AMP00310
      WRITE (6,1003)                                                   AMP00320
 1003 FORMAT (1X,'DO YOU WANT THE SAME VALUE OF R, C, L FOR EACH STAGE?'AMP00330
     1,/,' YES OR NO')                                                 AMP00340
      READ (5,110,END=11) ANS                                          AMP00350
  110 FORMAT (A2)                                                      AMP00360
      IF (ANS.EQ.YES) ISTEMP=1                                         AMP00370
   11 WRITE (6,1004)                                                   AMP00380
 1004 FORMAT (/,' NOW ENTER THE R, C, L FOR EACH STAGE',               AMP00390
     1/, 'UNITS     OHM FARAD HENRY')                                 AMP00400
   15 DO 20 I=1,ISTEMP                                                 AMP00410
      WRITE (6,1005) I                                                 AMP00420
 1005 FORMAT (/,' STAGE ',I3,/,' R=')                                  AMP00430
      READ (5,100) R(I)                                                AMP00440
      WRITE (6,1006)                                                   AMP00450
 1006 FORMAT (' C=')                                                   AMP00460
      READ (5,100) C(I)                                                AMP00470
      WRITE (6,1007)                                                   AMP00480
 1007 FORMAT (' L=')                                                   AMP00490
      READ (5,100) L(I)                                                AMP00500
   20 CONTINUE                                                         AMP00510
      IF (IS.EQ.ISTEMP) GO TO 30                                       AMP00520
      DO 25 I=2,IS                                                     AMP00530
      R(I)=R(1)                                                        AMP00540
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      C(I)=C(1)                                                          AMP00550
      L(I)=L(1)                                                          AMP00560
   25 CONTINUE                                                           AMP00570
   30 WRITE (6,1008)                                                     AMP00580
 1008 FORMAT (/,' FREQUENCY OF MAXIMUM GAIN...',//)                      AMP00590
      DO 40 I=1,IS                                                       AMP00600
      FM(I)=SQRT(1./(L(I)*C(I)))/6.2832                                  AMP00610
      WRITE (6,1009) I,FM(I)                                             AMP00620
 1009 FORMAT (' STAGE ',I3,2X,F15.8,'CYCLES/SEC')                        AMP00630
   40 CONTINUE                                                           AMP00640
   41 WRITE (6,1010)                                                     AMP00650
 1010 FORMAT(//,' ENTER THE READOUT PARAMETERS, START, INCR, END',       AMP00660
     1/,'UNITS ARE HERTZ (FREQ.)')                                       AMP00670
      READ (5,100,END=41) Q1,Q2,Q3                                       AMP00680
      WRITE (6,1011)                                                     AMP00690
 1011 FORMAT (//,20X,' FREQUENCY       GAIN',/)                          AMP00700
      NINCR=(Q3-Q1)/Q2+1                                                 AMP00710
      Q1=Q1-Q2                                                           AMP00720
      DO 50 I=1,NINCR                                                    AMP00730
      Q1=Q1+Q2                                                           AMP00740
      W=6.2832*Q1                                                        AMP00750
      G=1                                                                AMP00760
      DO 45 J=1,IS                                                       AMP00770
      Z1=R(J)**2+W*W*L(J)**2                                             AMP00780
      Z2=(1.-W*W*L(J)*C(J))**2+(W*W*R(J)**2)*C(J)**2                     AMP00790
      G=G*SQRT(Z1/Z2)                                                    AMP00800
   45 CONTINUE                                                           AMP00810
   50 WRITE (6,1012) Q1,G                                                AMP00820
 1012 FORMAT (10X, F15.8, 6X, F15.8)                                     AMP00830
      WRITE (6,1013)                                                     AMP00840
 1013 FORMAT (' DO YOU WANT TO RUN THE PROGRAM AGAIN? YES OR NO')        AMP00850
      READ (5,110,END=60) ANS                                            AMP00860
      IF (ANS.EQ.YES) GO TO 10                                           AMP00870
   60 STOP                                                               AMP00880
      END                                                                AMP00890

CP67USERID  TEMP0144    05/23/73    13.11.37    032-002-006    ********************
    5 FORMAT (/' THIS IS A PROGRAM TO TEST YOUR ABILITY TO CALCULATE COLCON00010
     1LISIONS.',/' THERE IS A POOL TABLE THAT LOOKS LIKE THIS...'/       CON00020
     2' (-24,36)   X---------------X   (24,36)',/                       CON00030
     3 6(12X,'|',15X,'|',/),                                           CON00040
     4' (-24, 0)   X       0       X   (24, 0)',/                       CON00050
     5 6(12X,'|',15X,'|',/),                                           CON00060
     6' (-24,-36)  X---------------X   (24,-36)')                      CON00070
    6 FORMAT (//' THE X''S ARE POCKETS AT THE GIVEN COORDINATES.  THE 0 CON00080
     1IN THE',/' MIDDLE IS THE CUE BALL AT (0,0).  THE GAME IS PLAYED ASCON00090
     2 FOLLOWS:'          ,//' I WILL GENERATE THE COORDINATES OF THE BACON00100
     3LL YOU WANT TO HIT,',/' REFERRED TO AS THE TARGET BALL.  YOU MUST CON00110
     4DIRECT THE CUE BALL SUCH'/' THAT IT STRIKES THE TARGET BALL AND SECON00120
     5NDS IT TO A POCKET WITH THE',/' REQUIRED VELOCITY.  YOU WILL ENTERCON00130
     6 THE MASSES OF THE TWO BALLS AND',/' ANGLE AND VELOCITY OF THE CUBCON00140
     7 BALL.  THE MASSES MUST BE IN A RANGE ',/' FROM 1 TO 10 AND THE VECON00150
     8LOCITY OF THE CUE BALL MUST NOT BE GREATER')                     CON00160
    7 FORMAT (' THAN 25.'/                                             CON00170
     1     '    I WILL TELL YOU WHERE YOU HIT THE RAIL AND AT WHAT VELOCCON00180
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     2TTY.',/' AS A GUIDE, I WILL GIVE THE ANGLE AT WHICH THE CUE BALL',CON00190
     3      /' WILL STRIKE THE TARGET BALL HEAD ON AND AFTER EACH COLLISCON00200
     4ION, HOW',/' CLOSE TO HEAD ON THE COLLISION WAS.')                CON00210
      DIMENSION SX(10),SY(10),SV1(10),SV2(10)                           CON00220
      DATA SX/-8.,-8.,8.,8.,13.,13.,-15.,-16.,2.,-3./                   CON00230
      DATA SY/24.,-5.,-9.,19.,1.5,-9.,12.,1.,29.,-10./                  CON00240
      DATA SV1/15.,15.,16.,17.,13.,15.,15.,15.,15.,15./                 CON00250
      DATA SV2/17.,18.,18.,20.,15.,  17.,20.,18.,19.,17./               CON00260
      WRITE (6,5)                                                       CON00270
      WRITE (6,6)                                                       CON00280
      WRITE (6,7)                                                       CON00290
      DO 999 II=1,10                                                    CON00300
      TX=SX(II)                                                         CON00310
      TY=SY(II)                                                         CON00320
      AN=ATAN2(TY,TX)                                                   CON00330
      AND = AN*180.0/3.1415                                             CON00340
      IF (AND .LT. 0.0) AND = 360. + AND                                CON00350
      WRITE (6,10)TX,TY,SV1(II),SV2(II),AND                             CON00360
   10 FORMAT (/' THE TARGET BALL IS AT (',F5.1,',',F5.1,')',            CON00370
     1        /' REQUIRED VELOCITY RANGE IS ',F5.1,' TO ',F5.1,        CON00380
     2        /' THE HEAD ON ANGLE IS ',F7.2)                          CON00390
      DATA YES /'YES'/                                                  CON00400
      PI=3.1415                                                         CON00410
      WRITE (6,40)                                                      CON00420
   40 FORMAT (/' ENTER THE CUE BALL MASS AND THE TARGET BALL MASS',     CON00430
     1        /' IN THE FOLLOWING DECIMAL FORMAT:',                    CON00440
     2        /' CC.CTT.T')                                            CON00450
   45 READ (5,50) XMC,XMT                                               CON00460
      IF ( (XMC .GT. 10.) .OR. (XMT .GT. 10.) ) GO TO 54                CON00470
      GO TO 51                                                          CON00480
   54 WRITE (6,52)                                                      CON00490
   52 FORMAT (/' MASS NOT WITHIN LIMIT.')                               CON00500
      GO TO 45                                                          CON00510
   50 FORMAT (2F4.0)                                                    CON00520
   51 TOL=0.5                                                           CON00530
   55 WRITE (6,57)                                                      CON00540
   57 FORMAT (/' ENTER THE CUE BALL VELOCITY AND ANGLE',                CON00550
     1        /' VVV.V AAA.AA')                                        CON00560
      READ (5,60) CV,CA                                                 CON00570
   60 FORMAT (2F6.0)                                                    CON00580
      CAR = CA * PI/180.0                                               CON00590
      R = 1.0                                                           CON00600
      AL = AN - CAR                                                     CON00610
      D = SQRT ( (TY*TX) + (TY*TY) )                                    CON00620
      SR = D * SIN(AL)/(2.0*R)                                          CON00630
      IF ( ABS(SR) .GT.1.0) GO TO 64                                    CON00640
      T2 =   ARSIN(SR)                                                  CON00650
      T1 = T2 - AL                                                      CON00660
      G = D  / (COTAN(AL) + COTAN(T1) )                                 CON00670
      P = (1.0 - (ABS(G)/(2.0*R)))*100.0                                CON00680
      IF ( P .GT. 0.0 ) GO TO 66                                        CON00690
   64 WRITE (6,65)                                                      CON00700
   65 FORMAT (/' YOU HAVE MISSED THE TARGET BALL.  TRY AGAIN.')         CON00710
      GO TO 55                                                          CON00720
   66 A = XMT*XMT +XMT                                                  CON00730
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      B = -2.0*XMC*XMC*CV*COS(T2)                                          CON00740
      C = (XMC*XMC -YMC) * CV*CV                                           CON00750
      V2 = (-B+SQRT(B*B-4.0*A*C))/(2.0*A)                                  CON00760
      T22 = T2 + CAR                                                       CON00770
      DX = V2 * COS(T22) * 0.5                                             CON00780
      DY = V2 * SIN(T22) * 0.5                                             CON00790
      X = TX                                                               CON00800
      Y = TY                                                               CON00810
   68 X = X +DX                                                            CON00820
      Y = Y + DY                                                           CON00830
      IF ( ABS(X) - 24.0 ) 70,80,80                                        CON00840
   70 IF ( ABS(Y) - 36.0 ) 68,90,90                                        CON00850
   80 DDX = (ABS(X) -24.0)                                                 CON00860
      DDX = SIGN (DDX,X)                                                   CON00870
      X = X -DDX                                                           CON00880
      DDY = DDX * TAN(T22)                                                 CON00890
      Y = Y - DDY                                                          CON00900
      IF ( ABS(Y) - 36.0 ) 85,130,90                                       CON00910
   85 YA = ABS(Y)                                                          CON00920
      IF ( YA .LE. TOL ) GO TO 130                                         CON00930
      IF (  ABS ( YA - 36.0 ) .LE. TOL ) GO TO  130                        CON00940
      GO TO 100                                                            CON00950
   90 DDY = (ABS(Y) - 36.0)                                                CON00960
      DDY = SIGN (DDY,Y)                                                   CON00970
      DDX = DDY/TAN(T22)                                                   CON00980
      Y  = Y - DDY                                                         CON00990
      X = X - DDX                                                          CON01000
      IF ( ABS(X) - 24.0) 95,130,80                                        CON01010
   95 XA = ABS (X)                                                         CON01020
      IF ( ABS ( XA - 24.0 ) .LE. TOL ) GO TO 130                          CON01030
  100 WRITE (6,110) X,Y,V2                                                 CON01040
  110 FORMAT (/' YOU HIT THE RAIL AT (',F5.1,' , ',F5.1,                   CON01050
     1        ' ), WITH VELOCITY ',F8.3)                                   CON01060
      WRITE (6,120) P                                                      CON01070
  120 FORMAT (/' THE COLLISION WAS ',F5.1,' % HEAD ON.')                   CON01080
      GO TO 55                                                             CON01090
  130 IF ((V2 .GE.SV1(II)) .AND. (V2.LE.SV2(II))) GO TO 136                CON01100
      WRITE (6,135)                                                        CON01110
  135 FORMAT (/' YOU REACHED THE POCKET BUT THE VELOCITY WAS NOT ACCEPTACON01120
     1BLE.')                                                               CON01130
      GO TO 55                                                             CON01140
  136 WRITE (6,140)                                                        CON01150
  140 FORMAT (/' YOU SUNK THE BALL.')                                      CON01160
  150 WRITE (6,160)                                                        CON01170
  160 FORMAT (/' DO YOU WANT TO TRY AGAIN? ... YES OR NO')                 CON01180
      READ (5,170) YN                                                      CON01190
  170 FORMAT (A2)                                                          CON01200
      IF (YN .EQ. YES) GO TO 999                                           CON01210
      GO TO 1000                                                           CON01220
  999 CONTINUE                                                             CON01230
 1000 STOP                                                                 CON01240
      END                                                                  CON01250
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APPENDIX II

Typical Terminal Session

a) PROJCT

b) VARMAS

c) AMPLIF

d) TRAJCT

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$ proj ct
EXECUTION BEGINS ...
THH MINIMUM DIMENSIONS FOR A FIELDHOUSE USED FOR FOOTBALL
SOCCER , BASEBALL MUST BE DETERMINED . TO DO THIS , YOU
MUST ESTIMATE THE MAXIMUM HEIGHT , AND RANGE OF A PROJECTILE
WITH VARYING INITIAL VELOCITIES & ANGLES OF DEPARTURE .
AT FIRST YOU WILL BE GIVEN THE VALUES FOR THE INITIAL VELOCITY
AND ANGLE OF DEPARTURE . THE GIVEN VALUES WILL BE VARIED THREE
TIMES EACH . YOU WILL BE LATER ALLOWED TO ENTER YOUR OWN VALUES
IF YOUR ESTIMATES COME WITHIN 25% OF THE CORRECT ANSWERS , THE
ANSWERS WILL BE PRINTED OUT AND A NEW SET OF VALUES WILL BE
INSERTED . YIU WILL HAVE THREE TRIES PER SET OF VALUES .

IN PART ONE THE PROJECTILE IS A SOCCERBALL , DRAG IS
NEGLECTED .
IQITIAL VELOCITY IS    0 .1500000E 02FT/SEC ANGLE OF DEPARTURE IS  15.00DEGREES
GIVE YOUR ESTIMATE OF THE HIPOINT
50
YIUR HIPOINT ESTIMATE IS TOO HIGH .
ENTER A NEW ESTIMATE
25
*** LAST CHANCE ***
YOUR HIPOINT ESTIMATE IS TOO HIGH .
ENTER A NEW ESTIMATE
10
YOUR HIPOINT ESTIMATE IS TOO HIGH .
DID YOU REALLY TRY? ALL OF YOUR ESTIMATES WERE MORE
THAN 25% OFF !!
INITIAL VELOCITY IS    0 .1500000E 06FT/SEC ANGLE OF DEPARTURE IS  15.00DEGREES
****IOD ESTIMATE ***
THH  HIPOINT IS  0 .236E 00
INITIAL VELOCITY IS    0.1500000E 02FT/SEC ANGLE OF DEPARTURE IS  15 .00DEGRHES
GIVE YOUR ESTIMATE OF THE RANGE .
 .236e
YIZR RANGE ESTIMATE IS TOO SHORT
ENTER A NEW ESTIMATE
 .42e
*** LAST CHANCE ***
YIZR RANGE ESTIMATE IS TOO SHORT
ENTER A NEW ESTIMATE
 .7e
YIUR RANGE ESTIMATE IS TOO SHORT
DID YOU REALLY TRY? ALL OF YOUR ESTIMATES WERE MORE
THAN 25% OFF !!
IQITIAL VELOCITY IS    0 .1500000E 06FT/SEC ANGLE OF DEPARTURE IS  15.00DEGREES
INITIAL VELOCITY IS    4.1500000E 02FT/SEC ANGLE OF DEPARTURE IS  45 .00DEGREES
GIVE YOUR ESTIMATE OF THE HIPOINT



2
YOUR HIPOINT ESTIMATE IS TOO HIGH .
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ENTER A NEW ESTIMATE
 5
*** LAST CHANCE ***
YIUR HIPOINT ESTIMATE IS TOO LOW .
1 3
YIZR HIPOINT ESTIMATE IS TOO LOW .
DID YOU REALLY TRY? ALL OF YOUR ESTIMATES WERE MORE
THEN 25% OFF !!
INITIAL VELOCITY IS    0 .1500000E 02FT/SEC ANGLE OF DEPARTURE IS  45 .00DEGREES
***GOOD ESTIMATE ***
THH  HIPOINT IS  0 .176E 05
INITIAL VELOCITY IS    0 .1500000E 02FT/SEC ANGLE OF DEPARTURE IS  45 .00DEGREES
GIVE YOUR ESTIMATE OF THE RANGE .
2
YIZR RANGE ESTIMATE IS TOO LONG .
ENTER A NEW ESTIMATE
 5
*** LAST CHANCE ***
YIZR RANGE ESTIMATE IS TOO SHORT
ENTER A NEW ESTIMATE
1 8
YIUR RANGE ESTIMATE IS TOO SHORT
DID YOU REALLY TRY? ALL OF YOUR ESTIMATES WERE MORE
THEN 25% OFF !!
INITIAL VELOCITY IS    0 .1500000E 02FT/SEC ANGLE OF DEPARTURE IS  45 .00DEGREES
INITIAL VELOCITY IS    0 .1500000E 02FT/SEC ANGLE OF DEPARTURE IS  90 .00DEGREES
GIVE YOUR ESTIMATE OF THE HIPOINT
3 0
INITIAL VELOCITY IS    0 .1500000E 02FT/SEC ANGLE OF DEPARTURE IS  90 .00DEGREES
***GOOD ESTIMATE ***
THE  HIPOINT IS  0 .352E 01
INITIAL VELOCITY IS    0 .1500000E 02FT/SEC ANGLE OF DEPARTURE IS  90 .00DEGREES
GIYE YOUR ESTIMATE OF THE RANGE .
3
YIUR RANGE ESTIMATE IS TOO LONG .
ENTER A NEW ESTIMATE
1 5
*** LAST CHANCE ***
YIUR RANGE ESTIMATE IS TOO LONG .
ENTER A NEW ESTIMATE
 8
YIZR RANGE ESTIMATE IS TOO LONG .
DID YOU REALLY TRY? ALL OF YOUR ESTIMATES WERE MORE
THEN 25% OFF !!
INITIAL VELOCITY IS    0 .1500000E 02FT/SEC ANGLE OF DEPARTURE IS  90 .00DEGREES
IQITIAL VELOCITY IS    0 .4500000E 02FT/SEC ANGLE OF DEPARTURE IS  15 .00DEGREES
GIVE YOUR ESTIMATE OF THE HIPOINT
1
YIUR HIPOINT ESTIMATE IS TOO HIGH .
ENTER A NEW ESTIMATE
 5
*** LAST CHANCE ***
YIUR HIPOINT ESTIMATE IS TOO LOW .
6 5
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```
YIUR HIPOINT ESTIMATE IS TOO HIGH.
DID YOU REALLY TRY? ALL OF YOUR ESTIMATES WERE MORE
THEN 25% OFF!!
INITIAL VELOCITY IS   0.4500000E 02FT/SEC ANGLE OF DEPARTURE IS  15.00DEGREES
***GOOD ESTIMATE ***
THH  HIPOINT IS  0.212E 05
INITIAL VELOCITY IS   0.4500000E 02FT/SEC ANGLE OF DEPARTURE IS  15.00DEGREES
GIVE YOUR ESTIMATE OF THE RANGE.
2
YIZR RANGE ESTIMATE IS TOO LONG.
ENTER A NEW ESTIMATE
 7
*** LAST CHANCE ***
YIZR RANGE ESTIMATE IS TOO SHORT
ENTER A NEW ESTIMATE
1 5
YIUR RANGE ESTIMATE IS TOO SHORT
DID YOU REALLY TRY? ALL OF YOUR ESTIMATES WERE MORE
THAN 25% OFF!!
IQITIAL VELOCITY IS   0.4500000E 06FT/SEC ANGLE OF DEPARTURE IS  15.00DEGREES
INITIAL VELOCITY IS   0.4500000E 02FT/SEC ANGLE OF DEPARTURE IS  45.00DEGREES
GIVE YOUR ESTIMATE OF THE HIPOINT
1 5
YIUR HIPOINT ESTIMATE IS TOO LOW.
2
*** LAST CHANCE ***
YIZR HIPOINT ESTIMATE IS TOO HIGH.
ENTER A NEW ESTIMATE
1 8
YIUR HIPOINT ESTIMATE IS TOO LOW.
DID YOU REALLY TRY? ALL OF YOUR ESTIMATES WERE MORE
THEN 25% OFF!!
INITIAL VELOCITY IS   0.4500000E 02FT/SEC ANGLE OF DEPARTURE IS  45.00DEGRHHS
****OOD ESTIMATE ***
THH  HIPOINT IS  0.158E 02
INITIAL VELOCITY IS   0.4500000E 02FT/SEC ANGLE OF DEPARTURE IS  45.00DEGREES
GIYE YOUR ESTIMATE OF THE RANGE.
2
YIUR RANGE ESTIMATE IS TOO LONG.
ENTER A NEW ESTIMATE
1
*** LAST CHANCE ***
YIUR RANGE ESTIMATE IS TOO LONG.
ENTER A NEW ESTIMATE
 5
YOUR RANGE ESTIMATE IS TOO SHORT
DII YOU REALLY TRY? ALL OF YOUR ESTIMATES WERE MORE
THAN 25% OFF!!
INITIAL VELOCITY IS   0.4500000E 02FT/SEC ANGLE OF DEPARTURE IS  45.00DEGREES
IQITIAL VELOCITY IS   0.4500000E 06FT/SEC ANGLE OF DEPARTURE IS  90.00DEGREES
GIYE YOUR ESTIMATE OF THE HIPOINT
3
YIZR HIPOINT ESTIMATE IS TOO HIGH.
ENTER A NEW ESTIMATE
2
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*** LAST CHANCE ***
Y!UR HIPOINT ESTIMATE IS TOO HIGH.
ENTER A NEW ESTIMATE
1.6
Y!ZR HIPOINT ESTIMATE IS TOO LOW.
DID YOU REALLY TRY? ALL OF YOUR ESTIMATES WERE MORE
THEN 25% OFF!!
IQITIAL VELOCITY IS   0.4500000E 06FT/SEC ANGLE OF DEPARTURE IS  90.00DEGREES
****!OD ESTIMATE ***
THH  HIPOINT IS  0.316E 02
INITIAL VELOCITY IS   0.4500000E 02FT/SEC ANGLE OF DEPARTURE IS  90.00DEGREES
GIVE YOUR ESTIMATE OF THE RANGE.

2
Y!UR RANGE ESTIMATE IS TOO LONG.
ENTER A NEW ESTIMATE
1
*** LAST CHANCE ***
Y!UR RANGE ESTIMATE IS TOO LONG.
ENTER A NEW ESTIMATE
.7
Y!UR RANGE ESTIMATE IS TOO LONG.
DID YOU REALLY TRY? ALL OF YOUR ESTIMATES WERE MORE
THEN 25% OFF!!
IQITIAL VELOCITY IS   0.4500000E 02FT/SEC ANGLE OF DEPARTURE IS  90.00DEGREES
INITIAL VELOCITY IS   0.9000000E 02FT/SEC ANGLE OF DEPARTURE IS  15.00DEGREES
GIVE YOUR ESTIMATE OF THE HIPOINT
2.5
Y!UR HIPOINT ESTIMATE IS TOO LOW.
3.4
*** LAST CHANCE ***
Y!ZR HIPOINT ESTIMATE IS TOO LOW.
4
YOUR HIPOINT ESTIMATE IS TOO HIGH.
DID YOU REALLY TRY? ALL OF YOUR ESTIMATES WERE MORE
THEN 25% OFF!!
IQITIAL VELOCITY IS   0.9000000E 06FT/SEC ANGLE OF DEPARTURE IS  15.00DEGREES
****!OD ESTIMATE ***
THH  HIPOINT IS  0.848E 01
INITIAL VELOCITY IS   0.9000000E 02FT/SEC ANGLE OF DEPARTURE IS  15.00DEGREES
GIVE YOUR ESTIMATE OF THE RANGE.
3
YOUR RANGE ESTIMATE IS TOO LONG.
ENTER A NEW ESTIMATE
2
*** LAST CHANCE ***
Y!UR RANGE ESTIMATE IS TOO LONG.
ENTER A NEW ESTIMATE
1.4
YOUR RANGE ESTIMATE IS TOO SHORT
DII YOU REALLY TRY? ALL OF YOUR ESTIMATES WERE MORE
THEQ 25% OFF!!
INITIAL VELOCITY IS   0.9000000E 02FT/SEC ANGLE OF DEPARTURE IS  15.00DEGREES
INITIAL VELOCITY IS   0.9000000E 02FT/SEC ANGLE OF DEPARTURE IS  45.00DEGREES
GIVE YOUR ESTIMATE OF THE HIPOINT
3
YOUR HIPOINT ESTIMATE IS TOO HIGH.
```

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```
ENTER A NEW ESTIMATE
2 2
*** LAST CHANCE ***
Y!UR HIPOINT ESTIMATE IS TOO LOW .
2 7
YIZR HIPOINT ESTIMATE IS TOO LOW .
DID YOU REALLY TRY? ALL OF YOUR ESTIMATES WERE MORE
THAN 25% OFF !!
IQITIAL VELOCITY IS   0.9000000E 06FT/SEC ANGLE OF DEPARTURE IS  45.00DEGREES
***GOOD ESTIMATE ***
THH  HIPOINT IS  0.633E 02
INITIAL VELOCITY IS   0.9000000E 02FT/SEC ANGLE OF DEPARTURE IS  45.00DEGRHES
GIVE YOUR ESTIMATE OF THE RANGE .
3
YIZR RANGE ESTIMATE IS TOO LONG .
ENTER A NEW ESTIMATE
2
*** LAST CHANCE ***
Y!UR RANGE ESTIMATE IS TOO LONG.
ENTER A NEW ESTIMATE
1 6
Y!UR RANGE ESTIMATE IS TOO SHORT
DID YOU REALLY TRY? ALL OF YOUR ESTIMATES WERE MORE
THEN 25% OFF !!
INITIAL VELOCITY IS   0.9000000E 02FT/SEC ANGLE OF DEPARTURE IS  45.00DEGREES
INITIAL VELOCITY IS   0.9000000E 02FT/SEC ANGLE OF DEPARTURE IS  90.00DEGREES
GIVE YOUR ESTIMATE OF THE HIPOINT
1 9
YIZR HIPOINT ESTIMATE IS TOO LOW .
2 3
*** LAST CHANCE ***
Y!UR HIPOINT ESTIMATE IS TOO LOW .
2 6
YIZR HIPOINT ESTIMATE IS TOO LOW .
DID YOU REALLY TRY? ALL OF YOUR ESTIMATES WERE MORE
THEQ 25% OFF !!
INITIAL VELOCITY IS   0.9000000E 06FT/SEC ANGLE OF DEPARTURE IS  90.00DEGREES
***GOOD ESTIMATE ***
XHH  HIPOINT IS  0.127E 03
INITIAL VELOCITY IS   0.9000000E 02FT/SEC ANGLE OF DEPARTURE IS  90.00DEGREES
GIVE YOUR ESTIMATE OF THE RANGE.
3
YOUR RANGE ESTIMATE IS TOO LONG .
ENTER A NEW ESTIMATE
2 5
*** LAST CHANCE ***
Y!UR RANGE ESTIMATE IS TOO LONG .
ENTER A NEW ESTIMATE
1 9
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Y !UR RA.GE ESTIMATE IS TOO LONG .
DI I YOU REALLY TRY? ALL OF YOUR ESTIMATES WERE MORE
THEQ 25% OFF !!
INITIAL VELOCITY IS   0.9000GG0E 02FT/SEC ANGLE OF DEPAR TURE IS  90 .00EGRHHS
THH MINIMUM DIMENSIONS FOR A FIELDHOUSE USED FOR FOOTBALL
SOCCER , BASEBALL MUST BE DETER!!INED . TO DO THIS , YOU
MUST ESTIMATE THE MAXIMUM HEIGHT , AND RANGE OF A PROJECTILE
WITH VARYING INITIAL VELOCITIES & ANGLES OF DEPARTURE .
AT FIRST YOU WILL BE GIVEN THE VALUES FOR THE INITIAL VELOCITY
AND ANGLE OF DEPARTURE . THE GIVEN VALUES WILL BE VARIED THREE
TIMES EACH . YOU WILL BE LATER ALLOWED TO ENTER YOUR OWN VALUES
IF YOUR ESTIMATES COME WITHIN 25% OF THE CORRECT ANSWERS , THE
ANSWERS WILL BE PRINTED OUT AND A NEW SET OF VALUES WILL BE
INSERTED . YOU WILL HAVE THREE TRIES PER SET OF VALUES .

IN PART TWO THE PROJECTILE IS A BASEBALL , THE FORCE OF
DRAG IS AFFECTING THE MINIMUM RANGE , AND THE HEIGHT OF THE

ROJECTILE . ESTIMATE ACCORDINGLY . THE DRAG COEFFICIENT FOR A

ASEBALL IS 2 .
THE MINIMUM DIMENSIONS FOR A FIELDHOUSE USED FOR FOOTBALL
SOCCER , BASEBALL MUST BE DETERMINED . TO DO THIS , YOU
MUST ESTIMATE THE MAXIMUM HEIGHT , AND RANGE OF A PROJECTILE
WITH VARYING INITIAL VELOCITIES & ANGLES OF DEPARTURE .
AT FIRST YOU WILL BE GIVEN THE VALUES FOR THE INITIAL VELOCITY
AND ANGLE OF DEPARTURE . THE GIVEN VALUES WILL BE VARIED THREE
TIRHS EACH . YOU WILL BE LATER ALLOWED TO ENTER YOUR OWN VALUES
IF YOUR ESTIMATES COME WITHIN 25% OF THE CORRECT ANSWERS , THE
ANSWERS WILL BE PRINTED OUT AND A NEW SET OF VALUES WILL BE
INSERTED . YOU WILL HAVE THREE TRIES PER SET OF VALUES .

IN PART 3 THE PROJECTILE WILL EITHER BE A FOOTBALL

R A SOCCERBALL , YOU WILL CHOOSE . THE EFFECT OF DRAG IS NOT

EGLECTED . NOTE: DRAG COEFFICIENT OF A SPHEROID OF R=1 .5 IS 2

OR R=7 COEFF=3 . ALSO THE SHAPE OF THE FOOTBALL EFFECTS THE

RAG COEFFICIENT .
IS THE PROJECTILE A FOOTBALL (1 .0) OR A SOCCERBALL (0 .0)
football

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FOOTBALL

TRACEBACK  ROUTINE  CALLED FROM ISN   REG . 14   REG . 15   REG .  0   REG .  1
           IBCOM                      0001324C   00013498   00000005   00000024
           PROJCT                     40014CB2   00012000   FFFF06C0   00014CF8

ENTRY POINT=  00012000
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STANDARD FIXUP TAKEN , EXECUTION CONTINUING
IHC215I CONVERT - ILLEGAL   DECIMAL   CHARACTER O
OOOTBALL
TRACEBACK  ROUTINE  CALLED FROM ISN   REG. 14   REG. 15   REG. 0   REG. 1
           IBCOM                      0001324C   00013498   00000005   00000024
           PROJCT                     40014CB2   00012000   FFFF06C0   00014CF8
ENTRY POINT=  00012000
STANDARD FIXUP TAKEN , EXECUTION CONTINUING
IHC215I CONVERT - ILLEGAL   DECIMAL   CHARACTER O
OOOTBALL
TRACEBACK  ROUTINE  CALLED FROM ISN   REG. 14   REG. 15   REG. 0   REG. 1
           IBCOM                      0001324C   00013498   00000005   00000024
           PROJCT                     40014CB2   00012000   FFFF06C0   00014CF8
ENTRY POINT=  00012000
STANDARD FIXUP TAKEN , EXECUTION CONTINUING
IHC215I CONVERT - ILLEGAL   DECIMAL   CHARACTER T
OOOTBALL
TRACEBACK  ROUTINE  CALLED FROM ISN   REG. 14   REG. 15   REG. 0   REG. 1
           IBCOM                      0001324C   00013498   00000005   00000024
           PROJCT                     40014CB2   00012000   FFFF06C0   00014CF8
ENTRY POINT=  00012000
STANDARD FIXUP TAKEN , EXECUTION CONTINUING
IHC215I CONVERT - ILLEGAL   DECIMAL   CHARACTER B
OOOOBALL
TRACEBACK  ROUTINE  CALLED FROM ISN   REG. 14   REG. 15   REG. 0   REG. 1
           IBCOM                      0001324C   00013498   00000005   00000024
           PROJCT                     40014CB2   00012000   FFFF06C0   00014CF8
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$ varmas
EXECUTION BEGINS ...
A ROCKET WEIGHS 30000 LBS WHEN FUELED UP ON THE LAUNCH-
ING PAD . IT IS FIRED VERTICALLY UPWARD AND , AT BURNOUT ,
WEIGHS 10000 LBS GASES ARE EXHAUSTED WITH A VELOCITY
OF 5000 FT /SEC , RELATIVE TO THE ROCKET (EXHAUST VELOCITY) ,
AND AT THE RATE OF 10 SLUGS/SEC , BOTH BEING ASSUMED TO BE
CONSTANT WHILE THE FUEL IS BURNING .

THH FOUR VALUES IN THIS PROBLEM WILL BE VARIED ONE AT A TIME
FOR EACH VARIABLE , YOU WILL BE GIVEN NEW VALUES , MAXIMUM OF 3 .
AFTER USING THE STOCK VALUES FOR ALL FOUR VARIABLES YOU WILL
BE GIVEN AN OPPORTUNITY TO ENTER YOUR OWN VALUES .
WEIGHT OF
FULL ROCKET     30000 .000
EMPTY ROCKET     10000 .000
FT/SEC .      5000 .000
SLUGS/SEC .       10 .000
ENTER ESTIMATES OF THRUST , & FINAL VELOCITY (IN LBS&
 MILES/HOUR)
THRUST=
10000
VELOCITY=
200
YOUR ESTIMATE OF BOTH      WAS MORE THAN 25% OFF
ENTER ESTIMATES OF THRUST , & FINAL VELOCITY (IN LBS&
 MILES/HOUR)
THRUST=
750
VELOCITY=
80
YOUR ESTIMATE OF BOTH      WAS MORE THAN 25% OFF
ENTER ESTIMATES OF THRUST , & FINAL VELOCITY (IN LBS&
 MILES/HOUR)
THRUST=
500
VELOCITY=
60
YOUR ESTIMATE OF BOTH      WAS MORE THAN 25% OFF
YOUR GUESSES ARE ALL USED UP , YOUR ESTIMATES ARE ALL
SHAKY
THE CORRECT THRUST IS  5010 .000
THH CORRECT FINAL VELOCITY IS  3745.267
NEW VALUES ,THH VARIABLE BEING VARIED IS THE WEIGHT OF FULL ROCKET
WEIGHT OF
FULL ROCKET     50000 .000
EMPTY ROCKET     10000 .000
FT/SEC .      5000 .000
SLUGS/SEC .       10 .000
ENTER ESTIMATES OF THRUST , & FINAL VELOCITY (IN LBS&
 MILES/HOUR)
THRUST=
10000
VELOCITY=
4000
YOUR ESTIMATE OF BOTH      WAS MORE THAN 25% OFF
```

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```
ENTER ESTIMATES OF THRUST , & FINAL VELOCITY (IN LBS&
 MILES/HOUR)
THRUST=

7000
VELOCITY=
3000
YOUR ESTIMATE OF BOTH     WAS MORE THAN 25% OFF
ENTER ESTIMATES OF THRUST , & FINAL VELOCITY (IN LBS&
 MILES/HOUR)
THRUST=
6000
VELOCITY=
2600
YOUR ESTIMATE OF BOTH     WAS MORE THAN 25% OFF
YOUR GUESSES ARE ALL USED UP , YOUR ESTIMATES ARE ALL
SHAKY
THE CORRECT THRUST IS  5010.000
THE CORRECT FINAL VELOCITY IS  5486.715
DO YOU WANT NEW INITIAL VALUES AT THIS POINT? YES OR NO
yes

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YES

TRACEBACK  ROUTINE  CALLED FROM ISN   REG. 14   REG. 15   REG. 0   REG. 1
           IBCOM                      00012B74   00012DD8   00000002   00000000
           VARMAS                     400145CA   00012000   FFFF06C0   00014610

ENTRY POINT=  00012000

STANDARD FIXUP TAKEN , EXECUTION CONTINUING

IHC215I CONVERT - ILLEGAL   DECIMAL   CHARACTER S

OES

TRACEBACK  ROUTINE  CALLED FROM ISN   REG. 14   REG. 15   REG. 0   REG. 1
           IBCOM                      00012F74   00012DD8   00000002   00000000
           VARMAS                     400145CA   00012000   FFFF06C0   00014610

ENTRY POINT=  00012000

STANDARD FIXUP TAKEN , EXECUTION CONTINUING
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NEW VALUES ,THH VARIABLE BEING VARIED IS THE WEIGHT OF EMPTY ROCKET
WEIGHT OF
FULL ROCKET     30000 .000
EMPTY ROCKET     20000 .000
FT/SEC .      5000 .000
SLUGS/SEC .        10 .000
ENTER ESTIMATES OF THRUST , & FINAL VELOCITY (IN LBS&
 MILES/HIUR)
THRUST=
5000
VELOCITY=
3000
YOUR ESTIMATE OF BOTH      WAS MORE THAN 25% OFF
ENTER ESTIMATES OF THRUST , & FINAL VELOCITY (IN LBS&
 MILES/HIUR)
THRUST=
2500
VELOCITY=
2000
YIUR ESTIMATE OF BOTH      WAS MORE THAN 25% OFF
ENTER ESTIMATES OF THRUST , & FINAL VELOCITY (IN LBS&
 MILES/HIUR)
THRUST=
2000
VELOCITY=
1500
YIUR ESTIMATE OF BOTH      WAS MORE THAN 25% OFF
YIUR GUESSES ARE ALL USED UP , YOUR ESTIMATES ARE ALL
SHEKY
THH CORRECT THRUST IS  5010.000
THH CORRECT FINAL VELOCITY IS  1382 .267
DO YOU WANT NEW INITIAL VALUES AT THIS POINT? YES OR NO
yes

IHC215I CONVERT - ILLEGAL   DECIMAL   CHARACTER Y

YES

TRACEBACK  ROUTINE  CALLED FROM ISN   REG . 14   REG . 15   REG .  0   REG .  1
           IBCOM                      00012B74   00012DD8   00000003   00000000
           VARMAS                     400145CA   00012000   FFFF06C0   00014610

ENTRY POINT=  00012000

STANDARD FIXUP TAKEN , EXECUTION CONTINUING

IHC215I CONVERT - ILLEGAL   DECIMAL   CHARACTER S

OES

TRACEBACK  ROUTINE  CALLED FROM ISN   REG . 14   REG . 15   REG .  0   REG .  1
           IBCOM                      00012B74   00012DD8   00000003   00000000
           VARMAS                     400145CA   00012000   FFFF06C0   00014610

ENTRY POINT=  00012000
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STANDARD FIXUP TAKEN  , EXECUTION CONTINUING
NEW VALUES ,THH VARIABLE BEING VARIED IS THE EXHAUST VELOCITY
WEIGHT OF
FULL ROCKET    30000 .000
EMPTY ROCKET    10000 .000
FT/SEC .   10000 .000
SLUGS/SEC .      10 .000
ENTER ESTIMATES OF THRUST , & FINAL VELOCITY (IN LBS&
 MILES/HIZR)
THRUST=
5010
VELOCITY=
3000
YIUR ESTIMATE OF BOTH     WAS MORE THAN 25% OFF
ENTER ESTIMATES OF THRUST , & FINAL VELOCITY (IN LBS&
 MILES/HIUR)
THRUST=
5010
VELOCITY=
3400
YIUR ESTIMATE OF BOTH     WAS MORE THAN 25% OFF
ENTER ESTIMATES OF THRUST , & FINAL VELOCITY (IN LBS&
 MILES/HIUR)
THRUST=
5010
VELOCITY=
4000
YIUR ESTIMATE OF BOTH     WAS MORE THAN 25% OFF
YIUR GUESSES ARE ALL USED UP , YOUR ESTIMATES ARE ALL
SHEKY
THH CORRECT THRUST IS 10010 .000
THH CORRECT FINAL VELOCITY IS  7490 .531
DO YOU WANT NEW INITIAL VALUES AT THIS POINT? YES OR NO

yes .

IHC215I CONVERT - ILLEGAL   DECIMAL   CHARACTER Y

YHS .

TRACEBACK  ROUTINE  CALLED FROM ISN   REG . 14   REG . 15   REG .  0   REG .  1

           IBCOM                      00012B74   00012DD8   00000004   00000000

           VARMAS                     400145CA   00012000   FFFF06C0   00014610

ENTRY POINT=  00012000

STANDARD FIXUP TAKEN  , EXECUTION CONTINUING
NEW VALUES ,THH VARIABLE BEING VARIED IS THE RATE OF FUEL EXHAUSTED
WEIGHT OF
FULL ROCKET    30000 .000
EMPTY ROCKET    10000 .000
FT/SEC .    5000 .000
SLUGS/SEC .      20 .000
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```
ENTER ESTIMATES OF THRUST , & FINAL VELOCITY (IN LBS&
 MI LES/HOUR)
THRUST=
5000
VELOCI T/=
3000
YIUR ESTIMATE OF BOTH     WAS MORE THAN 25% OFF
ENTER ESTIMATES OF THRUST , & FINAL VELOCITY (IN LBS&
 MI LES/HIZR)
THRUST=
10000
VELOCITY=
7500
YIZR ESTIMATE OF BOTH     WAS MORE THAN 25% OFF
ENTER ESTIMATES OF THRUST , & FINAL VELOCITY (IN LBS&
 MI LES/HIUR)
THRUST=
7500
VELOCITY=
6000
YIUR ESTIMATE OF BOTH     WAS MORE THAN 25% OFF
Y IUR GUESSES ARE ALL USED UP , YOUR ESTIMATES ARE ALL
SHAKY
THE CORRECT THRUST IS  5020 .000
THE CORRECT FINAL VELOCITY IS  3745 .267
DO YOU WANT NEW INITIAL VALUES AT THIS POINT? YES OR NO


yes
DO YOU WANT TO ENTER YOUR OWN VALUES"

no
ENTER WEIGHT OF ROCKET WITH FUEL .
35000
ENTER WEIGHT OF ROCKET EMPTY
20000
ENTER THE RATE AT WHICH FUEL IS EJECTED
4000
ENTER THE RATE AT WHICH FUEL IS BURNED
26000
WEIGHT OF
FULL ROCKET**************
EMPTY ROCKET**************
FT/SEC .**************
SLUGS/SEC .**************
ENTER ESTIMATES OF THRUST , & FINAL VELOCITY (IN LBS&
 MI LES/H IUR)
THRUST=

5700
VELOCI TY=
5000
YIUR ESTIMATE OF VELOCITY WAS MORE THAN 25% OFF
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```
ENTER ESTIMATES OF THRUST , & FINAL VELOCITY (IN LBS&
 MILES/HIUR)
THRUST=
6000
VELOCITY=

5500
YIZR ESTIMATE OF VELOCITY WAS MORE THAN 25% OFF
ENTER ESTIMATES OF THRUST , & FINAL VELOCITY (IN LBS&
 MILES/HIUR)
THRUST=
6500
VELOCITY=
6000
YIZR ESTIMATE OF VELOCITY WAS MORE THAN 25% OFF
YIUR GUESSES ARE ALL USED UP , YOUR ESTIMATES ARE ALL
SHEKY
THH CORRECT THRUST IS**********
THH CORRECT FINAL VELOCITY IS**********
DO YOU WANT TO ENTER YOUR OWN VALUES"
yes

SUMMARY OF ERRORS FOR THIS JOB    ERROR NUMBER    NUMBER OF ERRORS

                                      215               9
R; T=0.99/3.04 14.45.05
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$ amplif
EXECUTION BEGINS ...
ARE YOU FAMILIAR WITH THIS PROGRAM?
no

THIS PROGRAM WILL HELP YOU DESIGN A MULTISTAGE
BANDPASS AMPLIFIER . THE BASIC CIRCUIT CONSISTS OF A RESISTOR
AND INDUCTOR IN SERIES WITH A CAPACITOR MOUNTED PARALLEL TO
THE RESISTOR & INDUCTOR . YOU MAY SPECIFY UP TO 100 STAGES ,
AND YOU WILL ENTER THE VALUES FOR THE R , C , AND L FOR EACH
STAGE . AFTER YOU HAVE ENTERED THE VALUES ,THE PROGRAM WILL
GIVE YOU THE FREQUENCIES AT WHICH EACH STAGE GIVES MAXIMUM
GAIN . YOU CAN THEN GET A READOUT OF THE GAIN FOR YOUR AMPLIFIER
OVER A RANGE OF FREQUENCIES . TO DO THIS YOU WILL ENTER
THE INITIAL FREQUENCY , THE INCREMENT & THE FINAL FREQUENCY OF
THE RANGE OVER WHICH YOU WANT TO KNOW THE GAIN . THE DATA WILL
THEN BE PRINTED OUT , AND YOU WILL BE ASKED IF YOU WANT TO RUN
THE PROGRAM AGAIN .


H W MANY STAGES DOES YOUR AMPLIFIER HAVE?
IQCLUDE A DECIMAL POINT WITH ALL ENTRIES OR RESULTS WILL BE OFF BY SEVERAL
ORDERS OF MAGNITUDE .
10 .
DO YOU WANT THE SAME VALUE OF R , C , L FOR EACH STAGE?
YES OR NO
yes

NOW ENTER THE R , C , L FOR EACH STAGE

UNITS     OHM FARAD HENRY

STAGE   1
R=

2
C=
5.

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5.
TRACEBACK  ROUTINE  CALLED FROM ISN   REG . 14   REG . 15   REG .  0   REG .

           IBCOM                      00012EEC   000131E8   00000001   000149D

           AMPLIF                     4001496A   00012000   FFFF06C0   000149F

ENTRY POINT=  00012000

STANDARD FIXUP TAKEN , EXECUTION CONTINUING

IHC2151 CONVERT - ILLEGAL   DECIMAL   CHARACTER
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50.
TRACEBACK  ROUTINE  CALLED FROM ISN   REG. 14   REG. 15   REG.  0   REG.
           IBCOM                      00012EEC   000131E8   00000001   0001491
           AMPLIF                     4001496A   00012000   FFFF06C0   0001491
ENTRY POINT=  00012000
STANDARD FIXUP TAKEN , EXECUTION CONTINUING
L=
10 .
FREQZENCY OF MAXIMUM GAIN ...

STAGE    1   0.22507859E-02CYGLES/SEC
STAGE    2   0.22507859E-02CYGLES/SEC
STAGE    3   0.22507859E-02CYCLES/SEC
STAGE    4   0.22507859E-02CYGPES/SEC
STAGE    5   0.22507859E-02CYCLES/SEC
STAGE    6   0.22507859E-02CYCLES/WEC
STAGE    7   0.22507859E-02CYCLES/SEC
STAGE    8   0.22507859E-02CYGLES/SEC
STAGE    9   0.22507859E-02CYGLES/SEC
STAGE   10   0.22507859E-02CYCLES/SEC

ENTER THE READOUT PARAMETERS , START , INCR , END
NITS ARE HERTZ (FREQ.)
 .22507859

ENTER THE READOUT PARAMETERS , START , INCR , END
NITS ARE HERTZ (FREQ.)
IHC2181 FIOCS - I/O ERROR  BSAM INPUT  ERROR 01 ON FILE: 'FT08F002'
    07859
TRACEBACK  ROUTINE  CALLED FROM ISN   REG. 14   REG. 15   REG.  0   REG.
           IBCOM                      00013034   000131E8   00000008   000121
           AMPLIF                     4001496A   00012000   FFFF06C0   00014
ENTRY POINT=  00012000
STANDARD FIXUP TAKEN , EXECUTION CONTINUING
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                    FREQUENCY       GAIN

IHC207I IBCOM - PROGRAM INTERRUPT-   OVERFLOW   OLD PSW IS  8100000C92013070
TRACEBACK  ROUTINE  CALLED FROM ISN   REG. 14   REG. 15   REG.  0   REG.
           AMPLIF                     4001496A   00012000   FFFF06C0   00014
ENTRY POINT=  00012000

STANDARD FIXUP TAKEN , EXECUTION CONTINUING
         0.22507858E 00       0.32000169E-28
DO YOU WANT TO RUN THE PROGRAM AGAIN? YES OR NO

SUMMARY OF ERRORS FOR THIS JOB   ERROR NUMBER   NUMBER OF ERRORS
                                     218              1
                                     215              2
                                     207              1
R; T=0.61/1.63 14.52.31

yes
?CMS: YES

$ amplif
EXECUTION BEGINS...
ARE YOU FAMILIAR WITH THIS PROGRAM?
yes

HIW MANY STAGES DOES YOUR AMPLIFIER HAVE?
IQCLUDE A DECIMAL POINT WITH ALL ENTRIES OR RESULTS WILL BE OFF BY SEVERAL
ORIHRS OF MAGNITUDE.
5.0
DO YOU WANT THE SAME VALUE OF R, C, L FOR EACH STAGE?
YHS OR NO
no

NOW ENTER THE R, C, L FOR EACH STAGE

NITS     OHM FARAD HENRY

STAGE   1
R=
2000
C=
 .5
L=
40
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FREQUENCY OF MAXIMUM GAIN...

STAGE    1    0.35588046E-10CYGLES/SEC
STAGE    2    0.35588046E-10CYCLES/SEC
STAGE    3    0.35588046E-10CYCLES/SEC
STAGE    4    0.35588046E-10CYCLES/SEC
STAGE    5    0.35588046E-10CYGLES/SEC

ENTER THE READOUT PARAMETERS, START, INCR, END

NITS ARE HERTZ (FREQ)

35588046e
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$ traject
EXECUTION BEGINS...
THIS PROGRAM DEMONSTRATES THE RELATION OF FORCE TO VELOCITY.
IMAGINE A PARTICLE IN A COORDINATE SYSTEM. YOU WILL ENTER ALL
THE INITIAL DATA ON THE PARTICLE AND THE PROGRAM WILL GIVE YOU
READINGS ON THE POSITION OF THE PARTICLE WITH TIME.

YOU MUST ALWAYS INCLUDE THE DECIMAL POINT.

    ENTER THE INITIAL X AND Y COORDINATES.  INCLUDE DECIMAL POINTS.
X =
0.0
Y =
0.0
VELOCITY IN X DIRECTION=
10.0
VELOCITY IN Y DIRECTION=
10.0
ENTER THE ANGLE (IN DEGREES) AT WHICH THE FORCE
VECTOR ACTS.
ANG=
45.0
ENTER THE MAGNITUDE OF THE FORCE.
MAGNE =
1.0
DO YOU WANT THE ANGLE OF THE FORCE TO BE CONSTANT?
(INDEPENDENT OF THE VELOCITY)     YES   OR   NO

YES
HOW MANY READINGS DO YOU WANT?
20.0
      TIME          X             Y             ?
        T            XX            YY            V
   15.000        0.514         0.514         0.250
    3.000       10.177        10.177        11.300

   15.000        5.133         5.133         0.500
    3.000       10.351        10.351        11.010

   15.000        7.705         7.705         0.750
   10.000       10.530        10.530        11.000

   15.000       10.110        10.110         1.000
   11.750       10.707        10.707        15.110

   15.000       13.103        13.103         1.250
   10.000       10.881        10.881        15.700

   15.000       15.000        15.00          1.500
   00.000       11.001        11.001        15.010

   15.000       18.777        18.777         1.750
   00.100       11.077        11.077        15.000

   15.000       21.501        21.501         2.000
   10.571       11.131        11.131        10.110
```

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```
 45.000     24.489     24.489      2.250
 36.032     11.591     11.591     16.392

 45.000     27.431     27.431      2.500
 38.793     11.768     11.768     16.642

 45.000     30.417     30.417      2.750
 43.030     11.945     11.945     16.892

 45.000     33.447     33.447      3.000
 47.301     12.121     12.121     17.142

 45.000     36.522     36.522      3.250
 51.610     12.298     12.298     17.392

 45.000     39.640     39.640      3.500
 56.060     12.475     12.475     17.642

 45.000     42.803     42.803      3.750
 60.537     12.652     12.652     17.892

 45.000     46.010     46.010      4.000
 65.065     12.828     12.828     18.142

 45.000     49.262     49.262      4.250
 69.666     13.005     13.005     18.392

 45.000     52.557     52.557      4.500
 74.327     13.182     13.182     18.642

 45.000     55.897     55.897      4.750
 79.050     13.359     13.359     18.892

 45.000     59.281     59.281      5.000
 83.835     13.536     13.536     19.142

IF YOU JUST ENTER MORE READINGS, ENTER THE NUMBER YOU WANT.
0.0
DO YOU WANT TO RUN THROUGH THE PROGRAM AGAIN?
YOU OR NO

YES
X =
0.0
Y =
0.0
VELOCITY IN X DIRECTION=
0.0
VELOCITY IN Y DIRECTION=
0.0
ENTER THE ANGLE (IN DEGREES) AT WHICH THE FORCE
VECTOR ACTS.
THI=
90.0
```

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```
ENTER THE MAGNITUDE OF THE FORCE.
MAGNI =
1.0
DO YOU WANT THE ANGLE OF THE FORCE TO BE CONSTANT?
(INDEPENDENT OF THE VELOCITY)     YES   OR   NO

YES
HOW MANY READINGS DO YOU WANT?
5.0
      ALPHA          X          Y          T
        D           VX         VY          V
     90.000      0.000      0.063      0.250
      0.063      0.000      0.250      0.250

     90.000      0.000      0.188      0.500
      0.188      0.000      0.500      0.500

     90.000      0.000      0.375      0.750
      0.375      0.000      0.750      0.750

     90.000      0.000      0.625      1.000
      0.625      0.000      1.000      1.000

     90.000      0.000      0.938      1.250
      0.938      0.000      1.250      1.250

     90.000      0.000      1.313      1.500
      1.313      0.000      1.500      1.500

IF YOU JUST ENTER MORE READINGS, ENTER THE NUMBER YOU WANT.
0.0
DO YOU WANT TO RUN THROUGH THE PROGRAM AGAIN?
YES OR NO

YES
X =
0.0
Y =
0.0
VELOCITY IN X DIRECTION=
0.0
VELOCITY IN Y DIRECTION=
10.0
ENTER THE ANGLE (IN DEGREES) AT WHICH THE FORCE
VECTOR ACTS.
ANU=
90.0
ENTER THE MAGNITUDE OF THE FORCE.
MAGNI =
1.0
DO YOU WANT THE ANGLE OF THE FORCE TO BE CONSTANT?
(INDEPENDENT OF THE VELOCITY)     YES   OR   NO
```

BEST COPY AVAILABLE

```
YES
HOW MANY READINGS DO YOU WANT?
6.0
     ALPHA          X              Y              T
        D           VX             VY             V
   90.000       0.000          2.563          0.250
    2.563       0.000         10.250         10.250

   90.000       0.000          5.188          0.500
    5.188       0.000         10.500         10.500

   90.000       0.000          7.875          0.750
    7.875       0.000         10.750         10.750

   90.000       0.000         10.625          1.000
   10.625       0.000         11.000         11.000

   90.000       0.000         13.438          1.250
   13.438       0.000         11.250         11.250

   90.000       0.000         16.313          1.500
   16.313       0.000         11.500         11.500

IF YOU JUST WERE MORE READINGS, ENTER THE NUMBER YOU WANT.
0.0
DO YOU WANT TO RUN THROUGH THE PROGRAM AGAIN?
YES OR NO

YES
X =
0.0
Y =
0.0
VELOCITY IN X DIRECTION=
-10
VELOCITY IN Y DIRECTION=
0.0
ENTER THE ANGLE (IN DEGREES) AT WHICH THE FORCE
VECTOR ACTS.
THT=
0.0
ENTER THE MAGNITUDE OF THE FORCE.
MAGNF =
1.0
DO YOU WANT THE ANGLE OF THE FORCE TO BE CONSTANT?
(INDEPENDENT OF THE VELOCITY)     YES   OR   NO

YES
HOW MANY READINGS DO YOU WANT?
6.0
     ALPHA          X              Y              T
        D           VX             VY             V
  180.000**********      0.0            0.250

**********************      0.0    **********

  180.000**********      0.0            0.500
```

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```
**********************      0.0   **********

  350.000**********         0.0         0.750

**********************      0.0   **********

  350.000**********         0.0         1.000

**********************      0.0   **********

  350.000**********         0.0         1.250

**********************      0.0   **********

  350.000**********         0.0         1.500

**********************      0.0   **********

IF YOU JUST AFTER MORE READINGS, ENTER THE NUMBER YOU WANT.
0.000000000000
DO YOU WANT TO RUN THROUGH THE PROGRAM AGAIN?
YES OR NO

YES
X =
0.0
Y =
0.0
VELOCITY IN X DIRECTION=
0.0
VELOCITY IN Y DIRECTION=
-10
ENTER THE ANGLE (IN DEGREES) AT WHICH THE FORCE
VECTOR ACTS.
THETA=
90.0
ENTER THE MAGNITUDE OF THE FORCE.
MAGNITUDE =
1.0
DO YOU WANT THE ANGLE OF THE FORCE TO BE CONSTANT?
(INDEPENDENT OF THE VELOCITY)      YES   OR   NO

YES
HOW MANY READINGS DO YOU WANT?
5.0
      ALPHA          X            Y            T
        D            TX           TY           V
   -90.000      0.000**********      0.250

*********      0.000**********************

   -90.000      0.000**********      0.500

*********      0.000**********************
```

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```
  -90.000      0.000**********      0.750

*********      0.000**********************

  -90.000      0.000**********      1.000

*********      0.000**********************

  -90.000      0.000**********      1.250

*********      0.000**********************

  -90.000      0.000**********      1.500

*********      0.000**********************

IF YOU JUST AFTER MORE READINGS, ENTER THE NUMBER YOU WANT.
0.0
DO YOU WANT TO RUN THROUGH THE PROGRAM AGAIN?
YES OR NO

YES
X =
0.0
Y =
0.0
VELOCITY IN X DIRECTION=
0.0
VELOCITY IN Y DIRECTION=
-50.0
ENTER THE ANGLE (IN DEGREES) AT WHICH THE FORCE
VECTOR ACTS.
PHI=
90.0
ENTER THE MAGNITUDE OF THE FORCE.
MAGNI =
3.0
DO YOU WANT THE ANGLE OF THE FORCE TO BE CONSTANT?
(INDEPENDENT OF THE VELOCITY)      YES   OR   NO

YES
HOW MANY READINGS DO YOU WANT?
5.0
     ALPHA          X             Y             T
       D            VX            VY            V
  -90.000       0.000       -2.438       0.250
    2.438       0.000       -0.750       0.750

  -90.000       0.000       -4.813       0.500
    4.813       0.000       -0.500       0.500

  -90.000       0.000       -7.125       0.750
    7.125       0.000       -0.250       0.250

  -90.000       0.000       -9.375       1.000
    9.375       0.000       -0.000       0.000
```

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```
 -00.000      0.000    -11.563      1.250
  11.563      0.000     -8.750      8.750

 -00.000      0.000    -13.000      1.500
  13.000      0.000     -8.500      8.500

IF YOU JUST AFTER MORE READINGS, ENTER THE NUMBER YOU WANT.
0.0
DO YOU WANT TO RUN THROUGH THE PROGRAM AGAIN?
YES OR NO

YES
X =
0.0
Y =
0.0
VELOCITY IN X DIRECTION=
0.0
VELOCITY IN Y DIRECTION=
0.0
ENTER THE ANGLE (IN DEGREES) AT WHICH THE FORCE
VECTOR ACTS.
ALF=
00.0
ENTER THE MAGNITUDE OF THE FORCE.
MAGNI =
-10.0
DO YOU WANT THE ANGLE OF THE FORCE TO BE CONSTANT?
(INDEPENDENT OF THE VELOCITY)     YES   OR   NO

YES
HOW MANY READINGS DO YOU WANT?
5.0
     ALPH          X           Y           T
        D         VX          VY          V
   00.000      0.000       0.063       0.250
    0.063      0.000       0.250       0.250

   00.000      0.000       0.188       0.500
    0.188      0.000       0.500       0.500

   00.000      0.000       0.375       0.750
    0.375      0.000       0.750       0.750

   00.000      0.000       0.625       1.000
    0.625      0.000       1.000       1.000

   00.000      0.000       0.938       1.250
    0.938      0.000       1.250       1.250

   00.000      0.000       1.313       1.500
    1.313      0.000       1.500       1.500

IF YOU JUST AFTER MORE READINGS, ENTER THE NUMBER YOU WANT.
0.0
DO YOU WANT TO RUN THROUGH THE PROGRAM AGAIN?
YES OR NO
```

BEST COPY AVAILABLE

```
YES
X =
0.0
Y =
0.0
VELOCITY IN X DIRECTION=
0.0
VELOCITY IN Y DIRECTION=
0.0
ENTER THE ANGLE (IN DEGREES) AT WHICH THE FORCE
VECTOR ACTS.
PHI=
90.0
ENTER THE MAGNITUDE OF THE FORCE.
MAGNF =
1.0
DO YOU WANT THE ANGLE OF THE FORCE TO BE CONSTANT?
(INDEPENDENT OF THE VELOCITY)     YES   OR   NO

NO
HOW MANY READINGS DO YOU WANT?
10.0
      ALPHA          X              Y              T
                     VX             VY             V
  180.000      -0.063         0.000          0.250
    0.063      -0.250         0.000          0.250

  200.565      -0.125        -0.063          0.500
    0.110      -0.250        -0.250          0.354

  220.736      -0.163        -0.100          0.750
    0.222      -0.073        -0.127          0.433

  250.754      -0.100        -0.088          1.000
    0.303       0.173        -0.150          0.500

  -80.715       0.002        -0.382          1.250
    0.382       0.108        -0.382          0.559

  -71.280       0.117        -0.139          1.500
    0.156       0.570        -0.200          0.612

  -53.638       0.312        -0.423          1.750
    0.526       0.000         0.036          0.001

  -36.604       0.473        -0.752          2.000
    0.500       0.617         0.288          0.707

  -20.087       0.630        -0.223          2.250
    0.619       0.515         0.534          0.750

   -3.979       0.703        -0.069          2.500
    0.705       0.374         0.098          0.701

IF YOU LUST AFTER MORE READINGS, ENTER THE NUMBER YOU WANT.
0.0
DO YOU WANT TO RUN THROUGH THE PROGRAM AGAIN?
YES OR NO

NO
```

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APPENDIX III

Questionnaire used by students in evaluating programs

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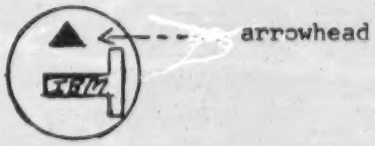
THE COMPUTER AS SIMULATOR

These programs were designed for use in introductory physics and engineering courses. The programs are designed to simulate laboratory exercises which could not be executed without great difficulty in the course of normal laboratory work. We would like you to help us evaluate these programs by using them and then giving us your evaluative comments about them.

INSTRUCTIONS: (Read entirely before proceeding.)

1. Use only terminals with CMS type balls (which have a small arrowhead on them, thus:)



   If terminals with CMS balls are not available, ask the attendant to change the type ball on an available terminal.

2. Turn "on" terminal.

3. Dial "1" on telephone provided next to every terminal. Wait for connection, followed by a high-pitch squeal. Then nest receiver in terminal-computer coupler.

4. Hit "attn" or "int" button, and wait for a message from the computer. Then type:

   1 hazelb

   and hit the "return" button. The computer will then proceed to type:

   ENTER PASSWORD:

   and a row of "garbage". Enter the password:

   alice

   over the row of garbage. The computer will then print out three lines, including the date.

5. You are now ready to use the four programs, to be used in the following order:

   a. $ trajct
   b. $ projct
   c. $ varmas
   d. $ amplif

6. To begin use of the first program, type the characters listed in 5a and hit the "return" button (as you must do after every input to the computer). When the program has ended, hit the "attn" or "int" button and type in the next string of characters listed in 5, e.g., $ projct. You may either re-run program 5a, or proceed to program 5b.

7. The programs are designed to introduce you to (or help you review) the practical application of certain elementary concepts in physics. Please run each program, (up to two times), until you achieve either success with the problems the computer presents to you, (as in the case of programs traject and varmas), or an intuitive grasp of the underlying material (principles), (as in the case of programs project and amplif).

8. After you have completed all four programs (as specified in 7), hit the "attn" or "int" button. Wait for the computer to print "CP", then type:

   log

   The computer will print a three line message. Then turn "off" terminal, and hang up the telephone receiver.

   SAVE ALL PRINTOUT:
   THIS IS ESSENTIAL
   TO THE EVALUATION:

9. After you have logged out, please answer the following questions:

   1. What physics or engineering courses are you presently taking? (Indicate course numbers.)

      _____

      _____

. We would like your evaluation of program _____ .

a. Rate the usefulness of this program for you as either an introduction or review of the underlying principles:

(Check one of the seven spaces that most corresponds to your own view. The labels at the ends of the scale describe spaces 1 and 7. The middle (4th) space represents the neutral opinion.)

Not useful at all	___ 1	___ 2	___ 3	___ 4	___ 5	___ 6	___ 7	Extremely useful

b. Do you think that the "computerization" of this problem (say, in comparison with a regular laboratory exercise in physics or engineering) added or detracted from its usefulness for you?

Added a great deal	___ 1	___ 2	___ 3	___ 4	___ 5	___ 6	___ 7	Detracted a great deal

c. Rate the "interest factor" of this problem as compared with the interest factor in the laboratory exercises you have performed in introductory physics courses (or engineering courses):

Much more interesting	___ 1	___ 2	___ 3	___ 4	___ 5	___ 6	___ 7	Much less interesting

d. PLEASE LIST ADDITIONAL COMMENTS IN AS MUCH DETAIL AS POSSIBLE. YOUR COMMENTS WILL HELP US A GREAT DEAL IN IMPROVING THE UTILITY OF THE PROGRAMS FOR STUDENTS IN INTRODUCTORY COURSES.

_____

_____

_____

_____

_____

_____

PLEASE CLIP THIS EVALUTATION FORM TO THE TOTAL PRINTOUT PRODUCED BY THIS EXERCISE AND RETURN TO:

DEAN BARRETT HAZELTINE
ROOM 355
BARUS & HOLLEY BUILDING
BROWN UNIVERSITY

PAYMENTS WILL BE SENT BY MAIL UPON RECIPT OF THESE DOCUMENTS.

THANK YOU VERY MUCH FOR YOUR HELP!!!